Carderock Division
Naval Surface Warfare Center
Bethesda, Md. 20084–5000

CARDIVNSWC–TR–61—CR—94/05 September 1994

Survivability, Structures, and Materials Directorate

Technical Report

An Experimental and Numerical Investigation of Specimen Size Requirements for Cleavage Fracture Toughness

by

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ABSTRACT

Cleavage fracture toughness can be influenced by specimen dimensions. Crack tip constraint can relax in small specimens, resulting in higher apparent toughness. Moreover, there is a statistical sampling effect, where thicker specimens tend to have lower toughness than thin specimens due to an increased sample volume.

In deeply notched bend and compact specimens, theoretical modeling, finite element analysis, and experimental data indicate that the results will not be significantly influenced by crack tip constraint as long as the following specimen size requirements are met:

$$a/W > 0.5 \qquad b \geq \frac{MJ_c}{\sigma_Y} \quad \text{and} \quad B/b \geq 1$$

where a is the crack length, W is the specimen width, B is the specimen thickness, b is the uncracked ligament length, J_c is the critical J value, σ_Y is the effective yield strength, and M is a dimensionless constant. These size requirements are conservative if M is set equal to 100; M = 50 appears to be adequate for many materials, but the authors recommend the stricter requirement until further validation is performed. When specimens meet the above requirements, fracture toughness should not be influenced by size, provided statistical thickness effects are taken into account.

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ADMINISTRATIVE INFORMATION

The work reported herein was funded under the Elastic-Plastic Fracture Mechanics of LWR Alloys Program at the Annapolis Detachment, Carderock Division, Naval Surface Warfare Center, Contract number N61533-92-K-0030. The Program is funded by the U.S. Nuclear Regulatory Commission under Interagency Agreement RES-93-002, FIN J6036. The Technical Program monitor is Dr. S.N. Malik at the USNRC. Technical monitoring of the contract was performed by Dr. Richard E. Link (CDNSWC 614).

1.0 INTRODUCTION

Classical fracture mechanics theory assumes that a single parameter, such as the stress intensity factor (K), the J-integral, or the crack tip opening displacement (CTOD), completely defines the crack tip stresses and strains. When this assumption is valid, a critical value of K, J or CTOD is a unique measure of a material's fracture toughness, which can be transferred to structural applications, much like small-scale tensile test data can be used to predict yielding in large and complex structures. However, the single-parameter crack tip description breaks down when extensive plasticity precedes fracture and the crack tip constraint relaxes. In such cases, measured fracture toughness values are a function of the size and geometry of the test specimen.

Fracture toughness testing standards, such as those published by the American Society for Testing and Materials (ASTM), often include specimen size requirements that are designed to ensure that the measured toughness is a material property, as opposed to a quantity that varies with specimen size. These size criteria vary in severity depending on the fracture parameter and material behavior. For example, size requirements for valid J tests are less stringent that K-based size criteria because K is valid only for linear elastic behavior, while the J-integral accounts for nonlinear material deformation. Appropriate size requirements can also depend on the micromechanism of fracture; cleavage fracture toughness is more sensitive to specimen size than ductile initiation toughness because cleavage is stress controlled, while ductile hole growth is predominately strain controlled.

In 1991, the authors [1] recommended specimen size criteria for deeply notched bend and compact specimens that fail by cleavage. This earlier study was based on 2-dimensional plane strain finite element analyses. We have recently completed a series of 3-D elastic-plastic finite element analyses on common test specimens [2]. These new results indicate that the earlier recommendations on specimen size were overly conservative. Moreover, experimental data that have become available since 1991 confirm that the recommendations in Ref. [1] are unnecessarily restrictive.

This report revisits the issue of size effects on cleavage fracture toughness in light of new data and analyses. In the present work, we consider only deeply notched single edge notched bend (SENB) specimens and compact (CT) specimens that fail by cleavage without significant prior stable crack growth.

2.0 THEORETICAL BACKGROUND

The present authors have developed a methodology for quantifying the effect of specimen size and geometry on cleavage fracture toughness [1-5]. This approach involves very detailed elastic-plastic finite element analysis which resolves crack tip stress fields, combined with a local failure criterion. The Anderson-Dodds model, which is summarized below, can predict the toughness of a particular specimen or structural geometry, given the toughness of a reference configuration. This methodology also quantifies the deviation from the single-parameter assumption, and thus can be used to infer specimen size requirements.

2.1 Cleavage Fracture Criterion

In order to quantify size and geometry effects on fracture toughness, one must assume a local failure criterion. In the case of cleavage fracture, a number of micromechanical models have been proposed [6-11], most based on weakest-link statistics. The weakest-link models assume that cleavage failure is controlled by the largest or most favorably oriented fracture-triggering particle. The actual trigger event involves a local Griffith instability of a microcrack which forms from a microstructural feature such as a carbide or inclusion; the Griffith energy balance is

satisfied when a critical stress is reached in the vicinity of the microcrack. The size and location of the critical microstructural feature dictate the fracture toughness; thus cleavage toughness is subject to considerable scatter.

The Griffith instability criterion implies fracture at a critical normal stress near the tip of the crack; the statistical sampling nature of cleavage initiation (i.e., the probability of finding a critical microstructural feature near the crack tip) suggests that the volume of the process zone is also important. Thus the probability of cleavage fracture in a cracked specimen can be expressed in the following general form:

$$F = F[V(\sigma_1)] \tag{1}$$

where F is the failure probability, σ_1 is the maximum principle stress at a point, and $V(\sigma_1)$ is the cumulative volume sampled where the principal stress is $\geq \sigma_1$. Equation (1) is sufficiently general to apply to any fracture process controlled by maximum principal stress, not just weakest link failure. For a specimen subjected to plane strain conditions, V = BA, where B is the specimen thickness and A is cumulative area on the x-y plane[1].

2.2 The J_o Parameter

For small scale yielding, dimensional analysis shows that the principal stress ahead of the crack tip can be written as

$$\frac{\sigma_1}{\sigma_o} = f\left(\frac{J}{\sigma_o r}, \theta\right) \tag{2}$$

where σ_o is a reference stress (usually the yield strength), r is the radial distance from the crack plane, and θ is the angle from the crack plane. Equation (2) implies that the crack tip stress fields depend only on J. It can be shown that the Hutchinson-Rice-Rosengren (HRR) singularity [12,13] is a special case of Eq. (2). When J dominance is lost, there is a relaxation in triaxiality; the principal stress at a fixed r and θ is less than the small scale yielding value.

Equation (2) can be inverted to solve for the radius corresponding to a given stress and angle:

$$r(\sigma_1 / \sigma_o, \theta) = \frac{J}{\sigma_o} g(\sigma_1 / \sigma_o, \theta) \tag{3}$$

Solving for the area inside a specific principal stress contour gives

$$A(\sigma_1 / \sigma_o) = \frac{J^2}{{\sigma_o}^2} h(\sigma_1 / \sigma_o) \tag{4}$$

where

[1]The standard fracture mechanics convention is used here, where x is the direction of crack propagation, and the y axis is normal to the crack plane.

$$h(\sigma_1 / \sigma_o) = \frac{1}{2} \int_{-\pi}^{\pi} g^2(\sigma_1 / \sigma_o, \theta) d\theta \tag{5}$$

Thus for a given stress, the area scales with J^2 in the case of small scale yielding. Under large scale yielding conditions, the test specimen or structure experiences a loss in constraint, and the area inside a given principal stress contour (at a given J value) is less than predicted from small scale yielding:

$$A(\sigma_1 / \sigma_o) = \phi \frac{J^2}{\sigma_o{}^2} h(\sigma_1 / \sigma_o) \tag{6}$$

where ϕ is a constraint factor that is ≤ 1. Let us define an *effective* J in large scale yielding that relates the area inside the principal stress contour to the small scale yielding case:

$$A(\sigma_1 / \sigma_o) = \frac{(J_o)^2}{\sigma_o{}^2} h(\sigma_1 / \sigma_o) \tag{7}$$

where J_o is the effective small scale yielding J; i.e., the value of J that would result in the area $A(\sigma_1/\sigma_o)$ if the structure were large relative to the plastic zone. Therefore, the ratio of the applied J to the effective J is given by

$$\frac{J}{J_o} = \sqrt{\frac{1}{\phi}} \tag{8}$$

The small scale yielding J value (J_o) can be viewed as *the effective driving force for cleavage*, while J is the *apparent* driving force.

Figure 1 illustrates a somewhat simpler method, based on ligament stress, for estimating J_o. The ligament stress method was applied in Ref. 2. The stress normal to the crack plane, σ_{yy}, is plotted against normalized distance. In small-scale yielding, the resulting curve is invariant because the absolute distance is scaled by J. When constraint relaxes, however, the normalized stress versus distance curve falls below the small-scale yielding result. The curves can be made to coincide (at least at a point) by multiplying the horizontal coordinate of the large-scale yielding curve by a constant. This constant is taken as the J/J_o ratio.

The J/J_o ratio quantifies the size dependence of cleavage fracture toughness. Consider, for example, a finite size test specimen that fails at $J_c = 200$ kPa m. If the J/J_o ratio were 2.0 in this case, a very large specimen made from the same material would fail at $J_c = 100$ kPa m. An equivalent toughness ratio in terms of crack tip opening displacement (CTOD) can also be defined.

One of the key assumptions of this model is that J_o does not depend on the principal stress, σ_1, in the case of the area method or the choice of normalized distance in the ligament stress method. This assumption, which is reasonable for most geometries up to high deformation levels, implies that the principal stress contours are self-similar in shape with respect to both deformation level and distance from the crack tip. In such cases, the contours for a given geometry can be scaled to the small-scale yielding reference solution to produce a unique J_o for

that particular case. If the principal stress contours scale, the ligament stress method produces a unique J_o which is very close to the value obtained by the area method. When the contours cease to be self-similar, the computed J_o value depends on the choice of principal stress contour or normalized distance in the area and ligament stress method, respectively.

The break-down of self-similarity in the principal stresses is most pronounced in deeply notched bend and compact geometries. When the ligament is fully yielded in such specimens, the crack tip stresses are dominated by the global bending field, which is nearly linear.

The authors are currently investigating a generalized scaling model that can be applied to cases where the principal stress contours do not scale. One difficulty with the more general model is that it contains parameters that are material dependent.

2.3 Three-Dimensional Effects

The constraint model described above considers only stressed *areas* in front of the crack tip. This model is incomplete, because it is the *volume* of material sampled ahead of the crack tip that controls cleavage fracture. The stressed volume obviously scales with specimen thickness (or crack front length in the more general case). Moreover, the stressed volume is a function of the constraint parallel to the crack front; higher constraint results in a larger volume, as is the case for in-plane constraint.

One way to treat three-dimensional constraint effects is to define an effective thickness based on an equivalent two-dimensional case. Consider a three-dimensional specimen that is loaded to a given J value. If we choose a principal stress value and construct contours at two-dimensional slices on the x-y plane, the area inside of these contours will vary along the crack front, as Fig. 2 illustrates. The volume can be obtained by summing the areas in these two-dimensional contours. This volume can then be related to an equivalent 2-D specimen loaded to the same J value:

$$V = 2\int_0^{B/2} A(\sigma_1, z)dz = B_{eff} A_c(\sigma_1) \tag{9}$$

where A_c is the area inside the σ_1 contour on the center plane of the 3-D specimen and B_{eff} is the effective thickness.

The effective thickness influences the cleavage driving force through a sample volume effect: longer crack fronts have a higher probability of cleavage fracture because more volume is sampled along the crack front. This effect can be characterized by a three-parameter Weibull distribution:

$$F = 1 - \exp\left[-\frac{B}{B_o}\left(\frac{K_{JC} - K_{\min}}{\Theta_K - K_{\min}} \right)^4 \right] \tag{10}$$

Where B is the thickness (or crack front length), B_o is a reference thickness, K_{min} is the threshold toughness, and Θ_K is the 63rd percentile toughness when $B = B_o$.

Consider two samples with effective crack front lengths B_1 and B_2. If a value of $K_{JC(1)}$ is measured for Specimen 1, the expected toughness for Specimen 2 can be inferred from Eq. (10) by equating failure probabilities:

$$K_{JC(2)} = \left(\frac{B_1}{B_2}\right)^{1/4} (K_{JC(1)} - K_{\min}) + K_{\min} \tag{11}$$

Equation (11) is a statistical thickness adjustment that can be used to relate two sets of data with different thicknesses.

3.0 FINITE ELEMENT RESULTS

Three-dimensional finite element analyses have recently been performed on both compact and three-point bend specimens. In the case of the single edge notched bend (SENB) specimens, width/thickness (W/B) ratios of 1, 2, and 4 were analyzed. Both deep and shallow notched SENB specimens were analyzed, but only the former (a/W = 0.5) is considered in the present report. In the case of the compact specimen, the standard B x 2B geometry with a/W = 0.6 was analyzed. Reference [2] describes the analysis methodology and results in detail. The key results are summarized below. Although Reference [2] considers the effect of strain hardening, only results for a Ramberg-Osgood exponent (n) of 10 are reported here. This hardening exponent is appropriate for typical reactor pressure vessel steels.

Figure 3 is a nondimensional plot of J_o at the midplane versus the average J through the thickness[2] of SENB specimens with various W/B ratios. The plane strain result from earlier work is shown for comparison. Note that for W/B = 1 and 2, J_o at the midplane lies well above the plane strain curve. For W/B = 4, J_o at the midplane follows the plane strain curve initially, but falls below the plane strain results at high deformation levels. The three-dimensional nature of the plastic deformation apparently results in a high level of constraint at the midplane when the uncracked ligament length is ≤ the specimen thickness.

Figure 4 is a plot of effective thickness, B_{eff}, as a function of deformation. The trends in this plot are consistent with Fig. 3; namely, that the constraint increases with decreasing W/B. Note that all three curves reach a plateau. Recall that B_{eff} is defined in such a way as to be a measure of the through-thickness relaxation of constraint, relative to the in-plane constraint at the midplane. At low deformation levels there is negligible relation at the midplane and $J \approx J_o$, but through-thickness constraint relation occurs, resulting in a falling B_{eff}/B ratio. At high deformation levels, the B_{eff}/B ratio is essentially constant, indicating that the constraint relaxation is proportional in three dimensions.

Section 2.2 introduced the J_o parameter and discussed the assumption that principal stress contours are self similar. When this self-similarity breaks down, it is no longer possible to define a unique J_o. Figure 5, which is a plot of J_o versus J for various principal stress values, indicates that the scaling assumption is not valid for SENB specimens at high deformation levels. The compact specimen exhibits similar variability in computed J_o values. Consequently, the present scaling model is not applicable to deeply notched bend and compact specimens at high deformation levels[3].

Figure 6 compares computed J_o values for SENB and compact specimens. The compact specimen appears to be more highly constrained (at the mid-plane) than the three-point bend geometry. The relative relaxation of constraint in the thickness direction is similar for the two specimen types, as Fig. 7 indicates.

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[2] In this report, the deformation level is characterized by the *average* J rather than a *local* J (e.g. at the midplane) because the former corresponds closely to experimental estimates of J inferred from load-displacement curves.

[3] The scaling model appears to be more reasonable for high hardening materials, as discussed in Ref. [2].

Although the scaling model in its present form is unable to provide an unambiguous prediction of the elevation of toughness (i.e., a unique J/J_o) due to constraint loss in deeply notched bend and compact specimens, the model in conjunction with the 3-D finite element results may provide some insight with respect to appropriate specimen size requirements for size-independent fracture toughness. In existing ASTM standards, size requirement for J-controlled fracture are typically written in the following form:

$$B, b \geq \frac{MJ_c}{\sigma_Y} \tag{12}$$

where b is the uncracked ligament length, M is a dimensionless constant, and σ_Y is the effective yield strength, defined as the average of yield and tensile strengths.

In earlier work, the authors [1] recommended $M = 200$. This recommendation was based on 2-D plane strain finite element results. However, 3-D results in Fig. 3 indicates the plane strain analyses underestimate the midplane constraint of a fracture toughness specimen. Consequently, $M = 200$ appears to be too restrictive.

Figure 8 is a re-plot of the curves in Fig. 6, but with both axes normalized by σ_Y rather than σ_o.[4] Based on J_o estimates from the area method with $\sigma_1/\sigma_o = 3.0$, $M = 100$ appears to be appropriate to ensure J-controlled fracture. The ligament stress method, however, predicts that the J versus J_o curves fall significantly below the 1:1 line for M values in the range of 50 to 75.

In the next section, we investigate alternative size criteria (M = 100 and M = 50) with experimental cleavage fracture toughness data.

4.0 VALIDATION WITH EXPERIMENTAL DATA

McCabe [14] recently published fracture toughness data for various sized specimens fabricated from A533 Grade B steel. This data set consisted of 1/2 T, 1T, 2T, and 4T compact specimens. Figure 9 (top portion) shows the measured fracture toughness values at -75°C. These data, as well as all subsequent data discussed in this report, are plotted in terms of K_{JC}, a K-equivalent of critical J values, defined as

$$K_{JC} = \sqrt{\frac{J_c E}{1 - \nu^2}} \tag{13}$$

The data plotted in the top portion of Fig. 9 exhibit an apparent size effect. Although the scatter bands overlap, the average toughness tends to decrease with increasing specimen size. However, when all of the data are adjusted to a fixed B_{eff} through Eq. (11), the size dependence disappears. (A reference thickness of 6 mm was chosen for this data set because it corresponds approximately to the lower plateau B_{eff} for the smallest specimens.) Thus the only observable size dependence in this data set can be explained by statistical effects (as opposed to constraint relaxation). The minimum ligament requirements of Eq. (12) are plotted in Fig. 9 for both $M = 50$ and $M = 100$. Note that all data but one point satisfy the size requirement when $M = 50$, but a significant number of specimens fail the $M = 100$ requirement. The latter size requirement is too strict for the data in Fig. 9 because it would unnecessarily invalidate data obtained from the smaller specimens.

[4]For a Ramberg-Osgood material with n = 10, $\sigma_o = 0.74\ \sigma_Y$.

Figures 10 and 11 show fracture toughness data for an A36 steel [15]. At -76°C, most of the data pass the M = 50 requirement, and there is no discernible size dependence in this data set when a B_{eff} adjustment is applied. At -43°C, however, all of the smallest specimens fail the M = 50 requirement and they tend to exhibit higher toughness than larger specimens.

A recent round-robin testing program conducted in Japan resulted in a very large database of mechanical properties of numerous heats of reactor pressure vessel steels and weldments. These data were provided to one of the authors (TLA) by the Electric Power Research Institute (EPRI). Selected cleavage fracture toughness data from this database are tabulated and analyzed in an upcoming EPRI report [16]. This database includes fracture toughness tests on a wide range of specimen sizes. Table 1 summarizes the portion of the Japanese database that is pertinent to the present work.

Figures 12 to 23 are plots of the fracture toughness data from the Japanese round robin. In each case, the top graph shows the unadjusted data, while the bottom graph shows the same data adjusted to a reference thickness. The size limits M = 50 and 100 are plotted on each graph for the case of 1T specimens. These plots, taken together, lead to the following observations:

- Data that satisfy the $M = 100$ requirement do not exhibit a size dependence when a thickness adjustment is made.
- Data that satisfy the $M = 50$ requirement but fail the $M = 100$ requirement do not appear to exhibit a significant size dependence, but the data are inconclusive because 1T specimens that fail the $M = 100$ requirement typically sustain substantial ductile crack growth prior to failure. The size requirements under consideration here apply only to cleavage without significant ductile tearing.
- Data in the upper transition region appear to exhibit an "inverse" size dependence, with larger specimens tending toward higher toughness. This effect is particularly pronounced when a thickness adjustment is made. Ductile tearing prior to cleavage may be responsible for this phenomena. Ductile growth tends to lower cleavage fracture toughness by re-sharpening the crack and causing more material to be sampled. This effect may be less pronounced in larger specimens because a given amount of ductile tearing comprises a smaller relative fraction of the uncracked ligament.

5.0 SUMMARY AND CONCLUSIONS

The Anderson-Dodds scaling model does not work well for deeply notched bend and compact specimens (at least for n = 10) because the principal stress contours are not self-similar, and it is not possible to obtain a unique J_o value. A generalized scaling model is currently being developed.

Because it is not possible to infer a unique J_o for standard test specimens, the scaling model does not give an unambiguous indication of appropriate size requirements. Provisionally, we recommend the following size requirements for J-controlled cleavage fracture:

$$a/W \geq 0.5 \qquad b \geq \frac{MJ_c}{\sigma_Y} \qquad B/b \geq 1.0$$

where $M = 100$. For some materials, a requirement of $M = 50$ appears to be sufficient, but further work is needed to validate this more relaxed requirement. The $M = 100$ requirement should be conservative.

Data that meet the above size requirement will still exhibit a statistical thickness dependence, but this effect can be taken into account through Eq. (11). It is important to point out that the above size requirement should be applied to data *before* any statistical thickness adjustment is made.

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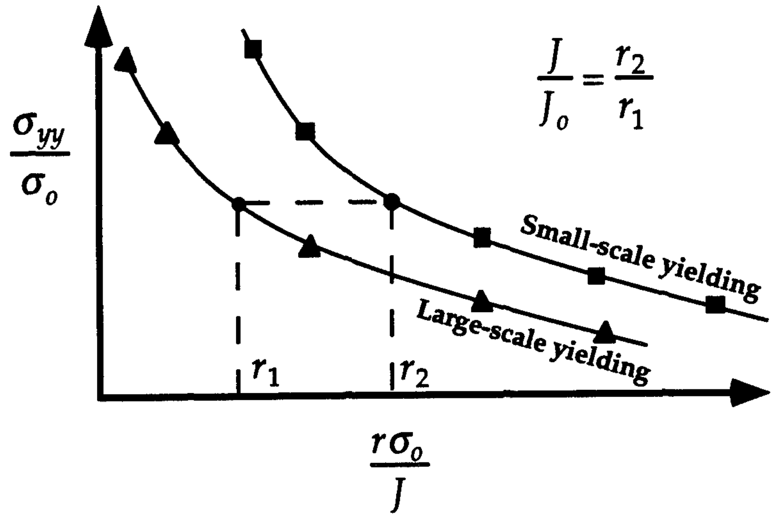
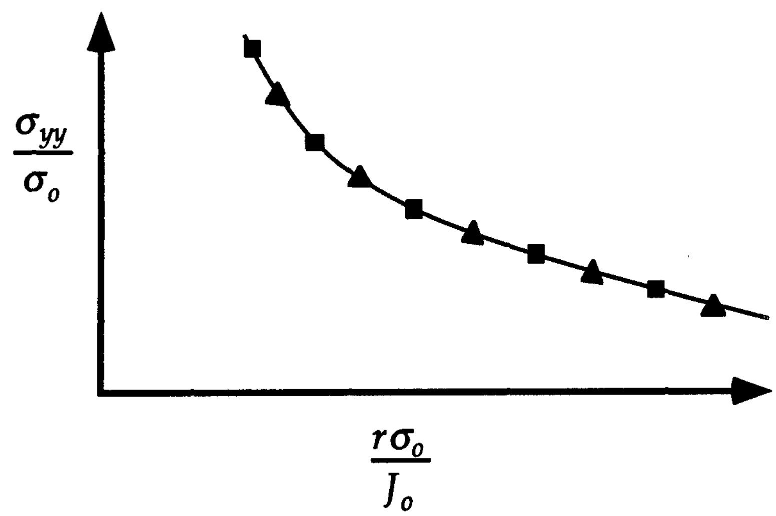
TABLE 1. **Summary of materials and test specimens from the Japanese round robin [16].**

Material Designation	Alloy	Compact Specimen Size(s)	3-Pt. Bend Specimen Size(s)
7HA	A533 B Class 1	1T, 2T, 10T	1T
7HB	A533 B Class 1	4T, 10T	1T
7HC	A508 Class 3	1T, 2T, 4T	1T
8HA	A533 B Class 1	1T	1T, 4T
8HB	A533 B Class 1	1T	1T, 4T
8HC	A508 Class 3	1T, 3T, 6T	1T, 4T
8HD	A508 Class 3	1T, 4T	–
8HE	A508 Class 3	–	1T, 4T
9HA (Base)	A533 B Class 1	1T	1T, 2T
9HA (Weld*)	A533 B Cl. 1, SAW	–	1T, 2T
9HC (Weld HAZ)	A508 Cl. 3, SAW	–	1T, 2T



(a) Normalized by *J*



(b) Normalized by J_o

FIGURE 1. Schematic illustration of the ligament stress method for estimating the effective driving force for cleavage (J_o).

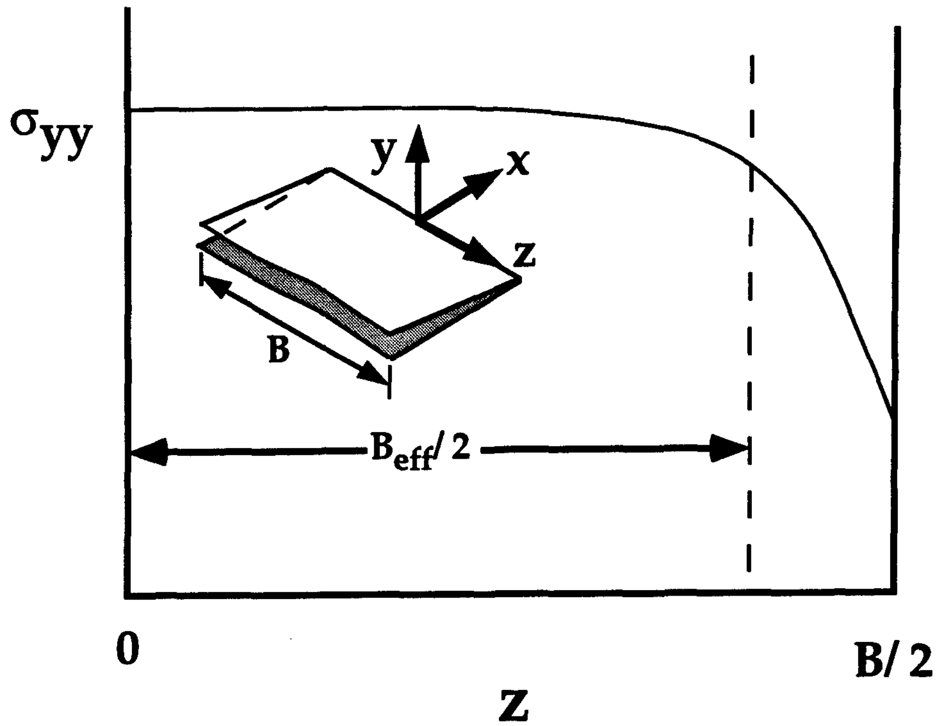


FIGURE 2. Schematic illustration of the effective crack front length, B_{eff}.

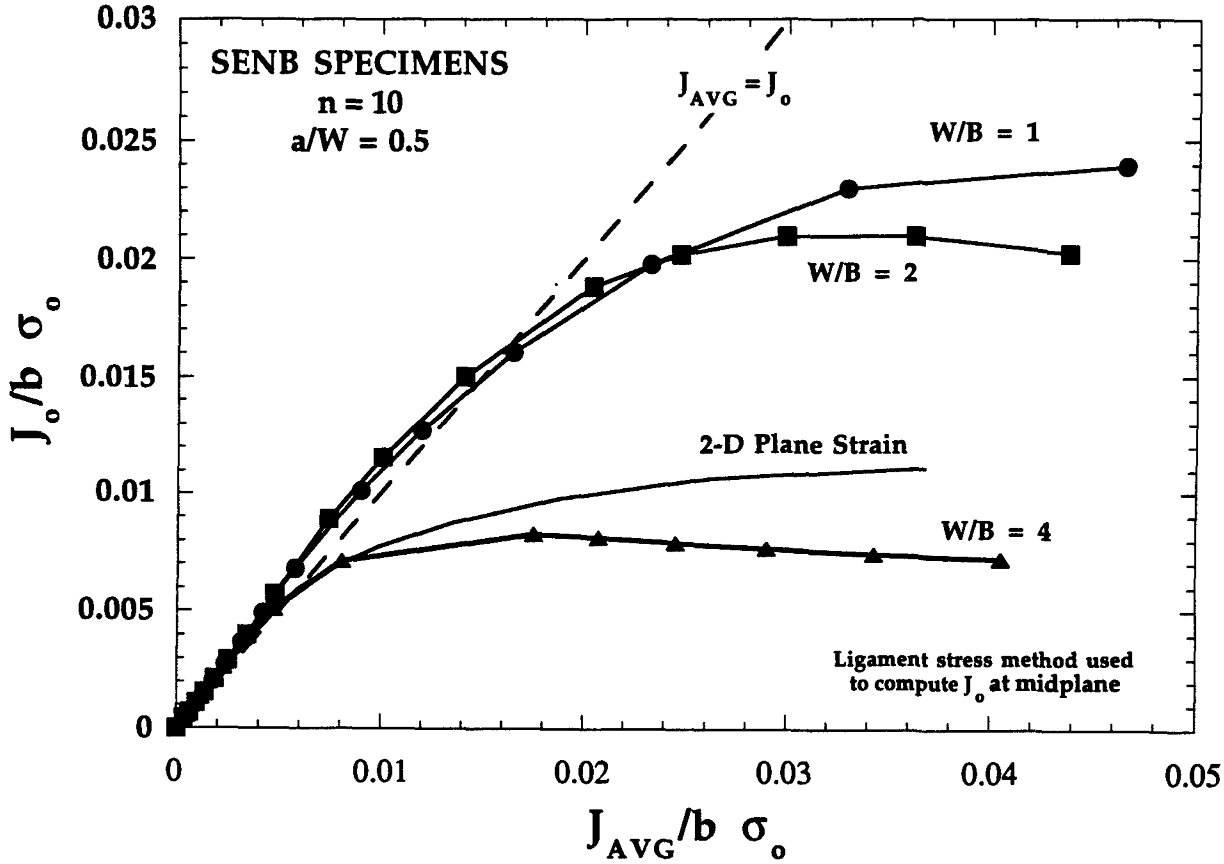


FIGURE 3. Effective driving force for cleavage fracture at the midplane of SENB specimens.

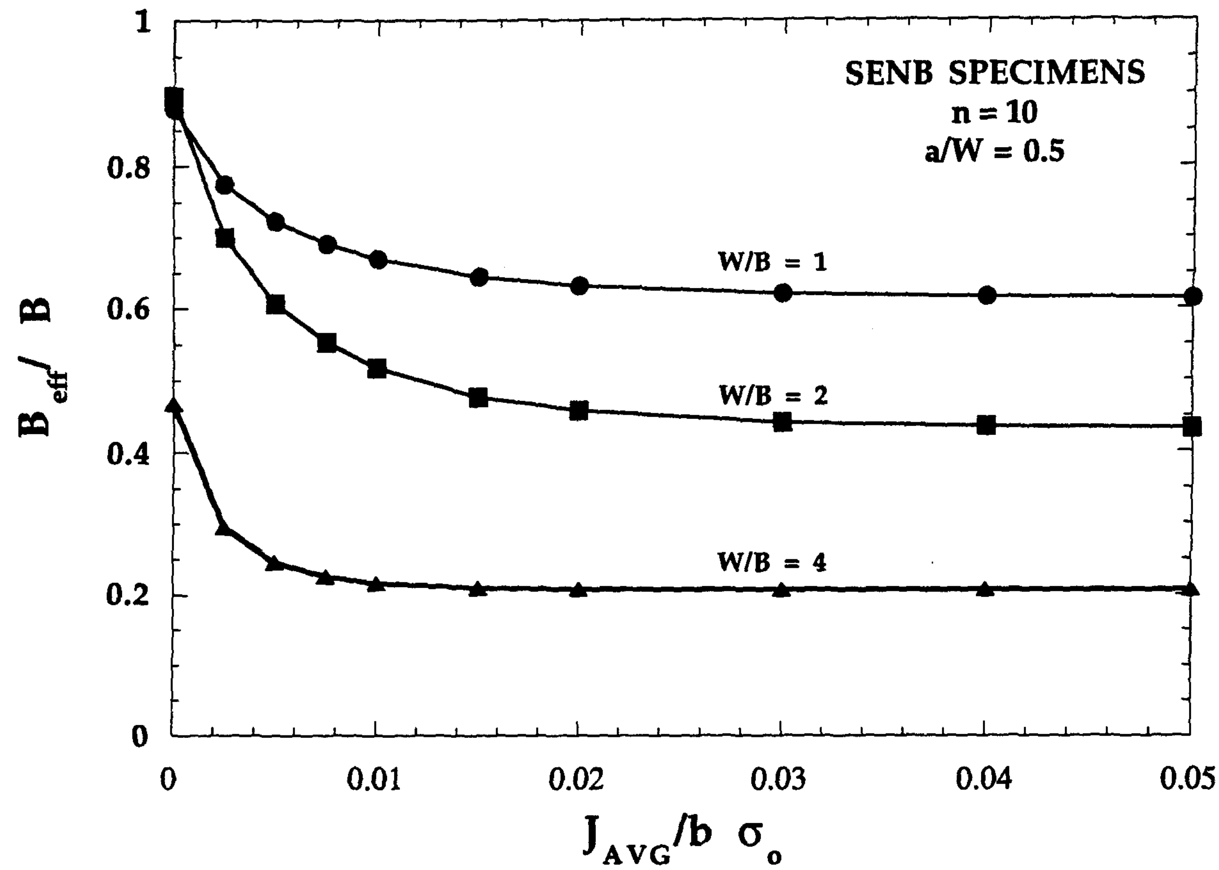


FIGURE 4. Effective thickness in SENB specimens as a function of geometry and deformation.

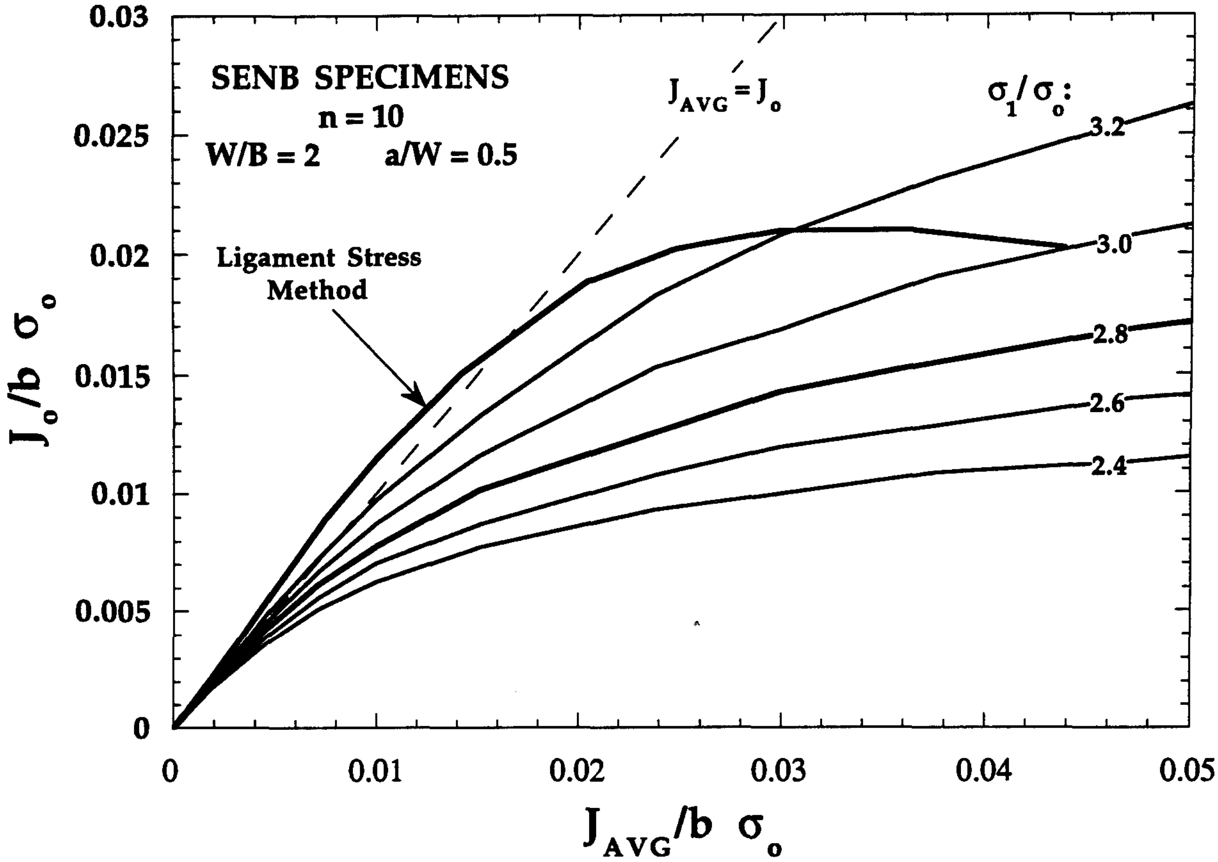


FIGURE 5. Effect of principal stress contour on J_0 estimates for standard B x $2B$ SENB specimens.

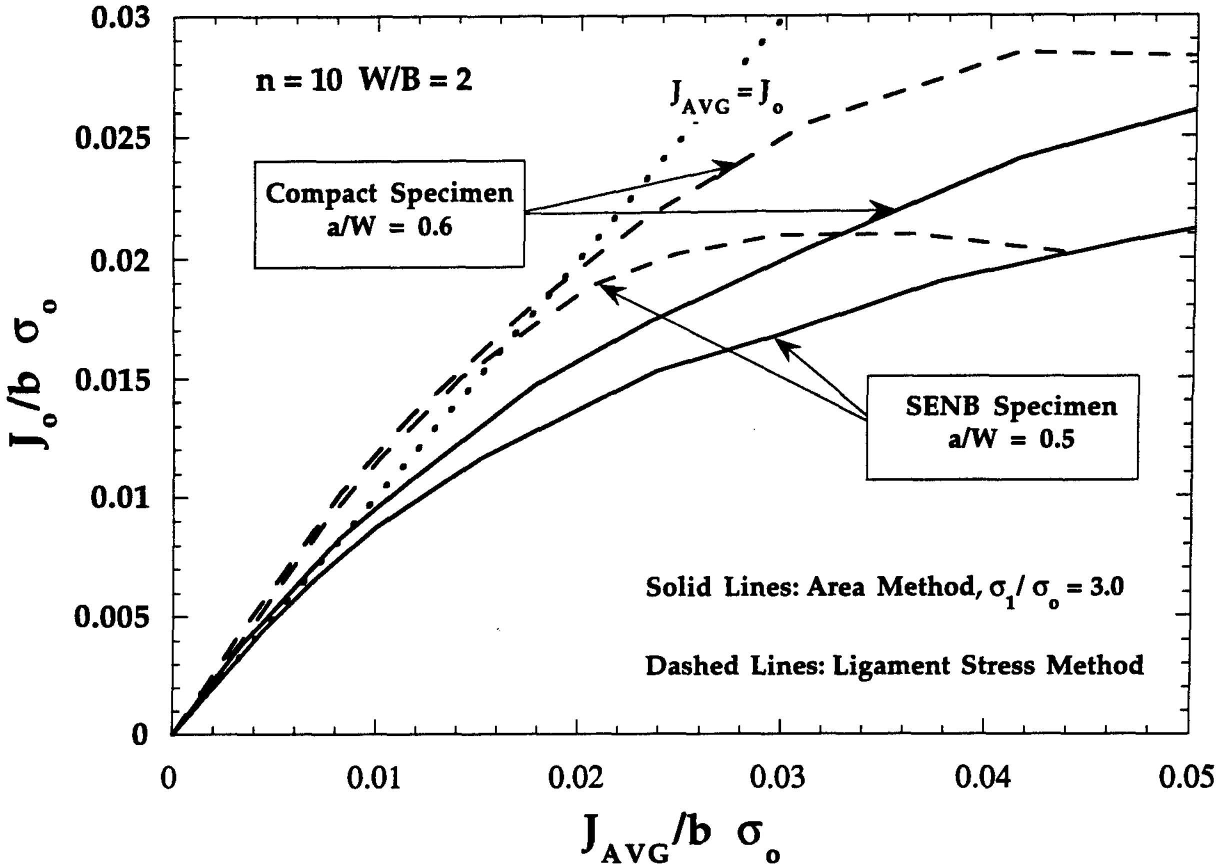


FIGURE 6. Comparison of effective cleavage driving force for SENB and compact specimens.

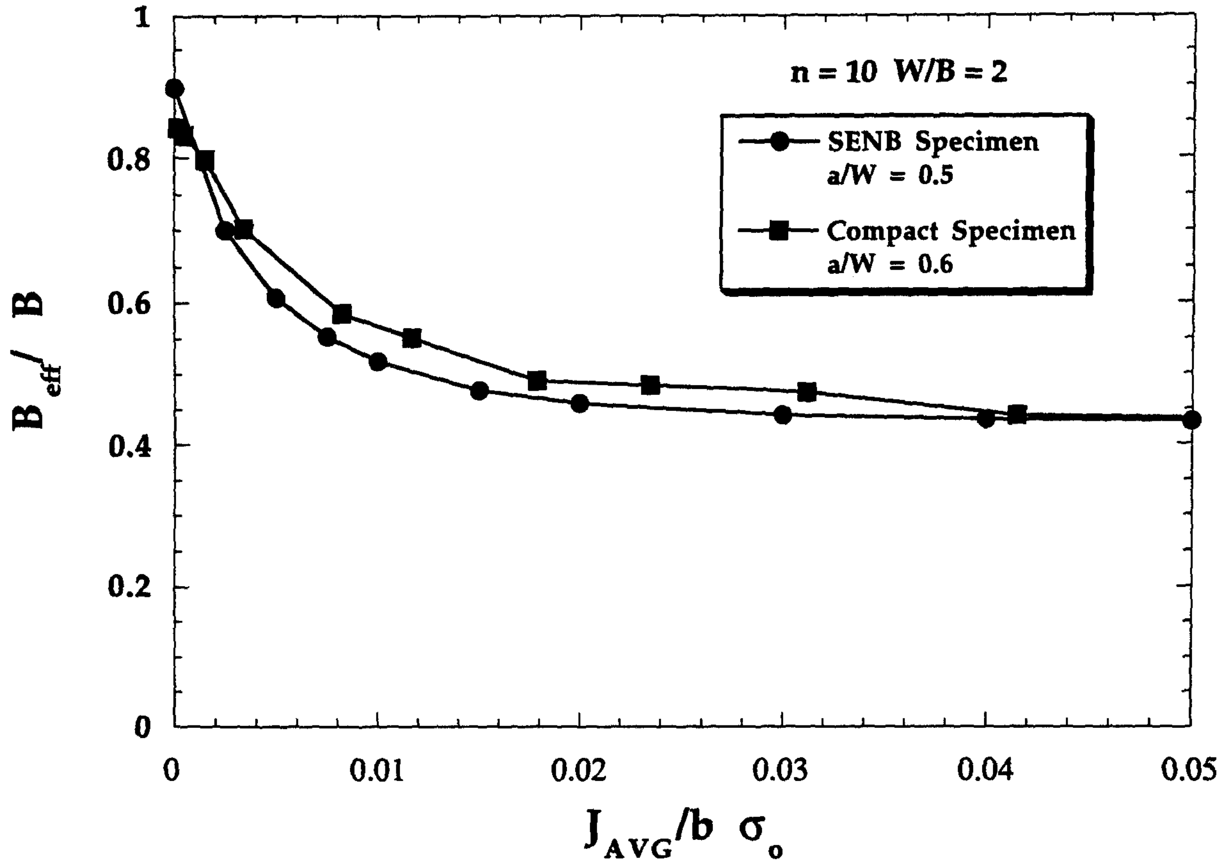


FIGURE 7. Comparison of effective thickness for SENB and compact specimens.

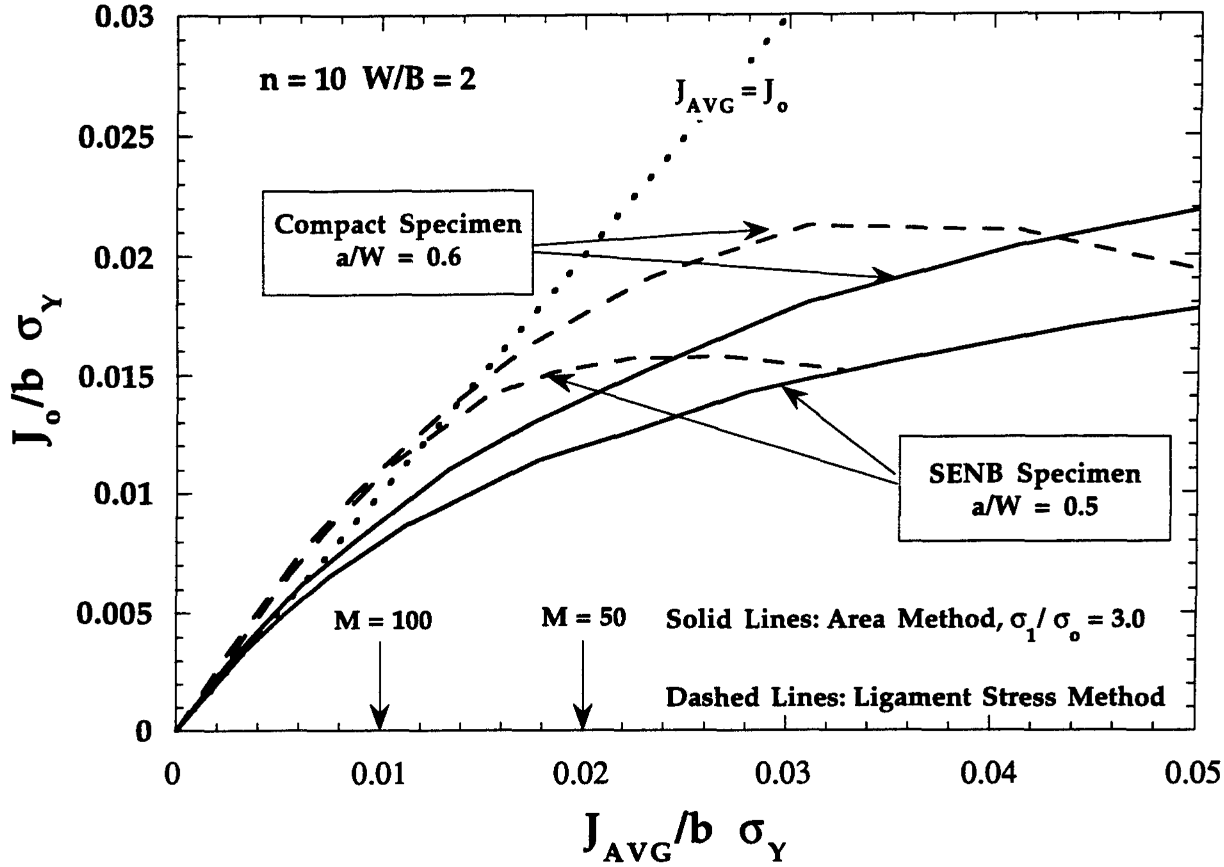


FIGURE 8. ***J_0* for SENB and compact specimens, normalized by flow stress rather than yield strength. The parameter *M* is defined in Eq. (12).**

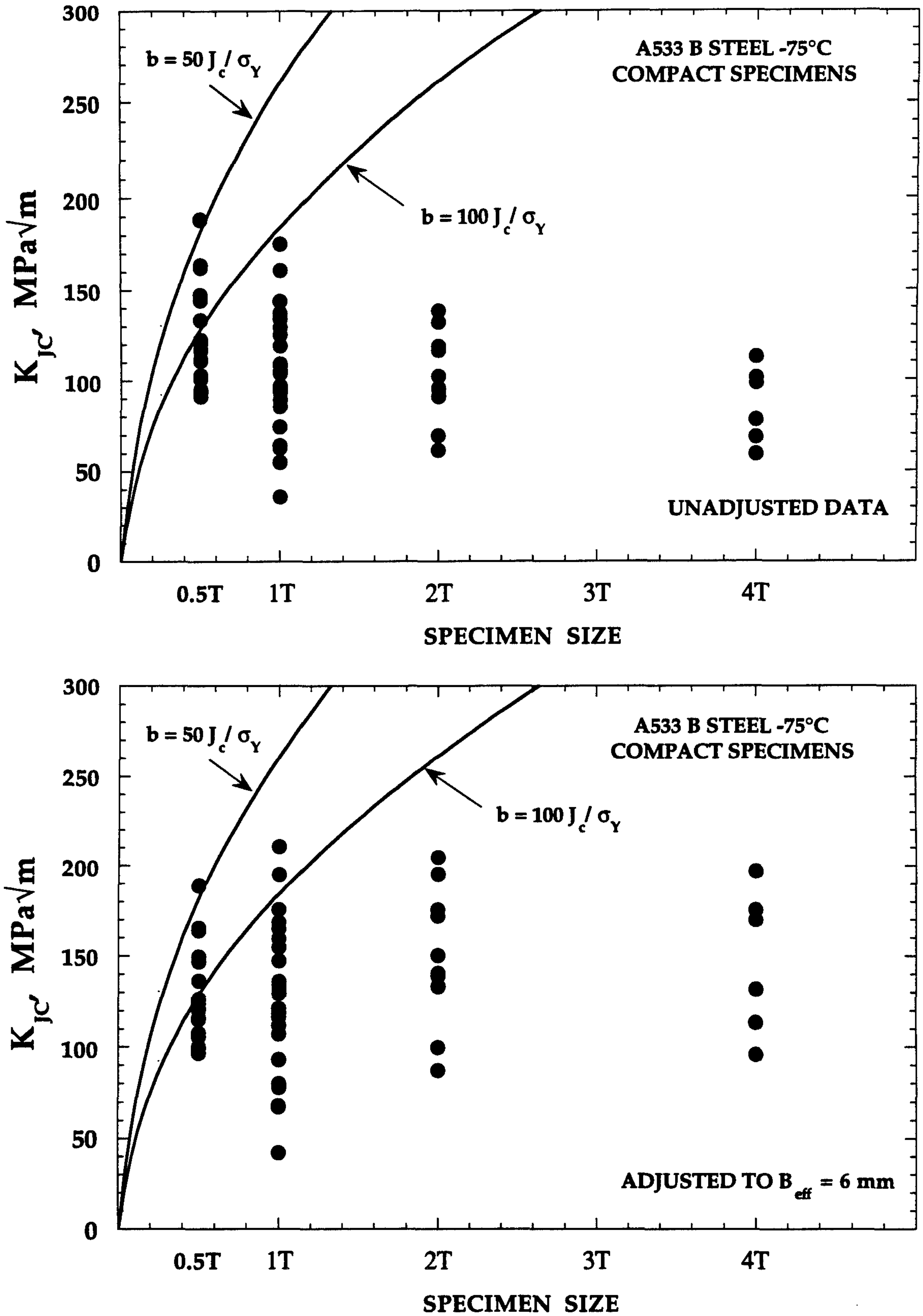
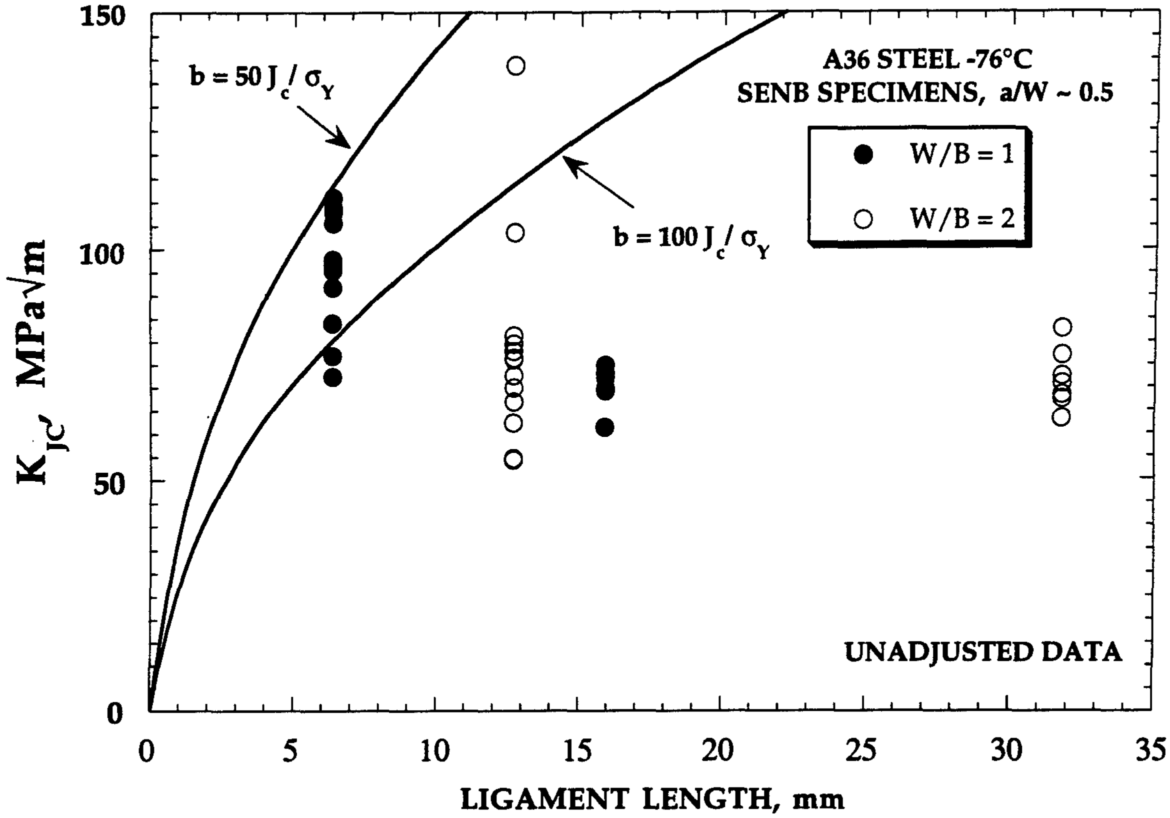


FIGURE 9. Fracture toughness data for A533 B steel at -75°C [14].



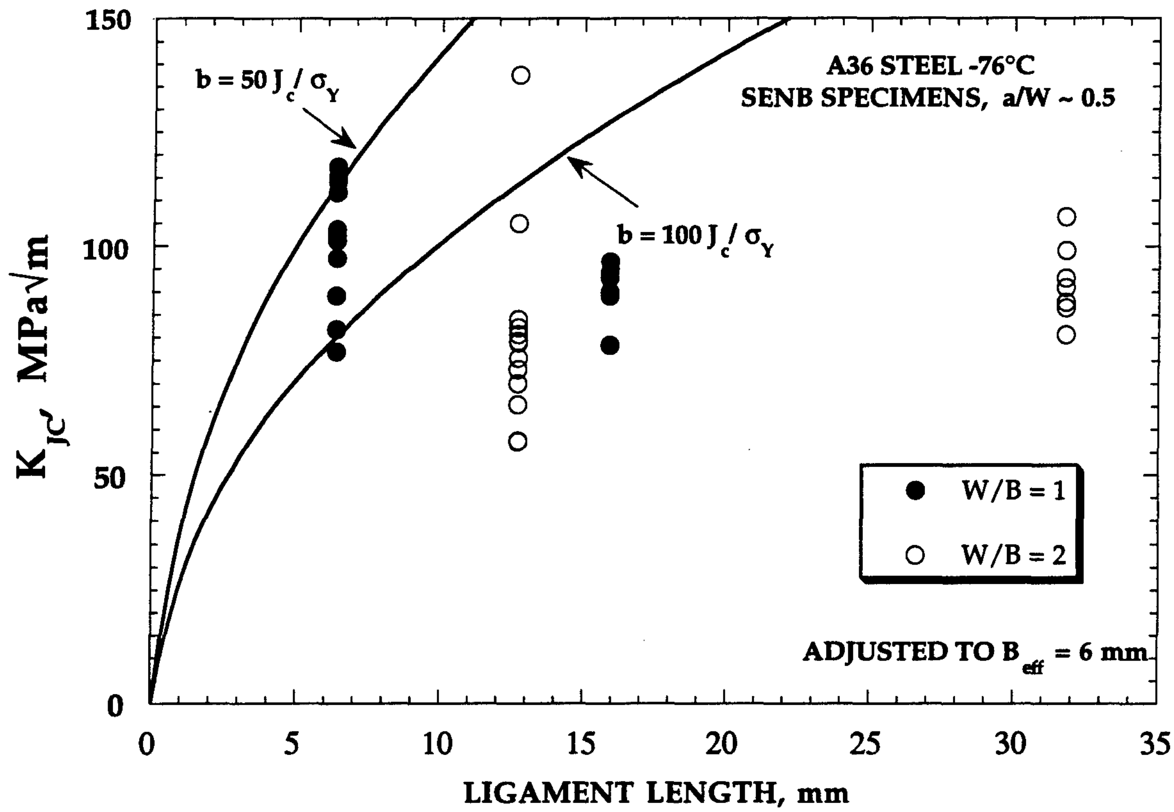
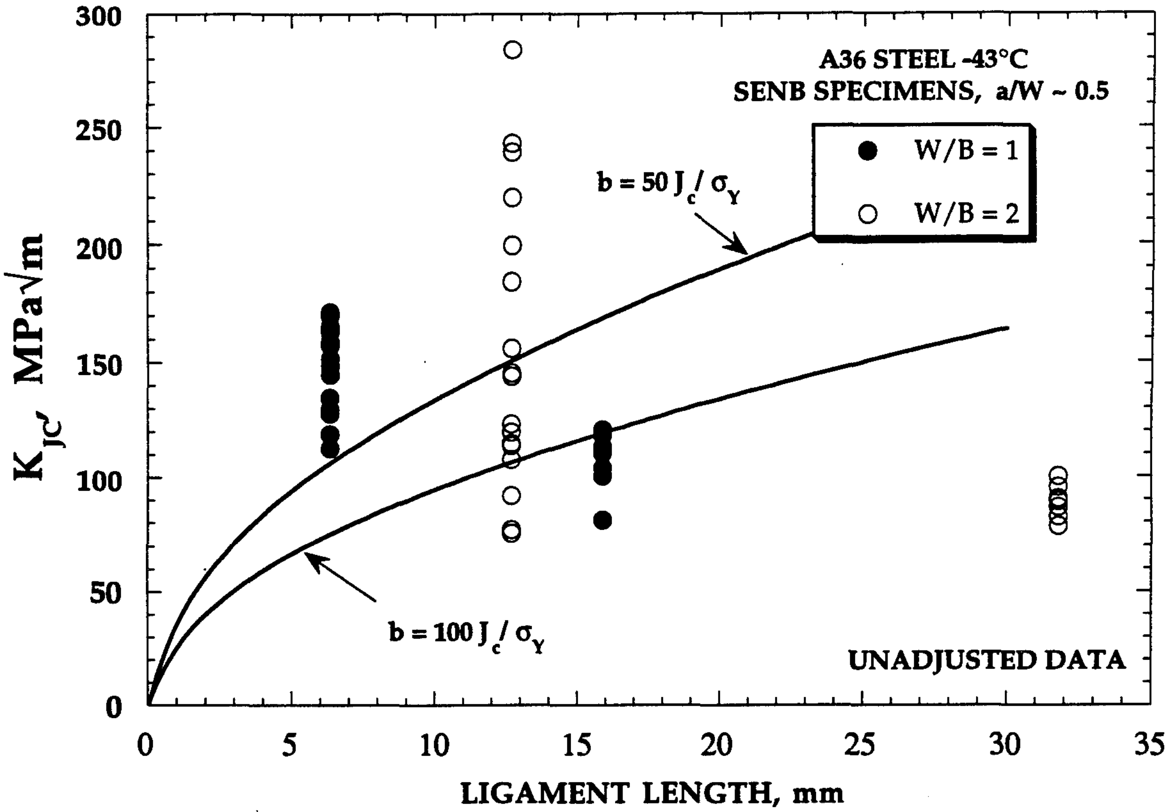


FIGURE 10. **Fracture toughness data for A36 steel at -76°C [15].**



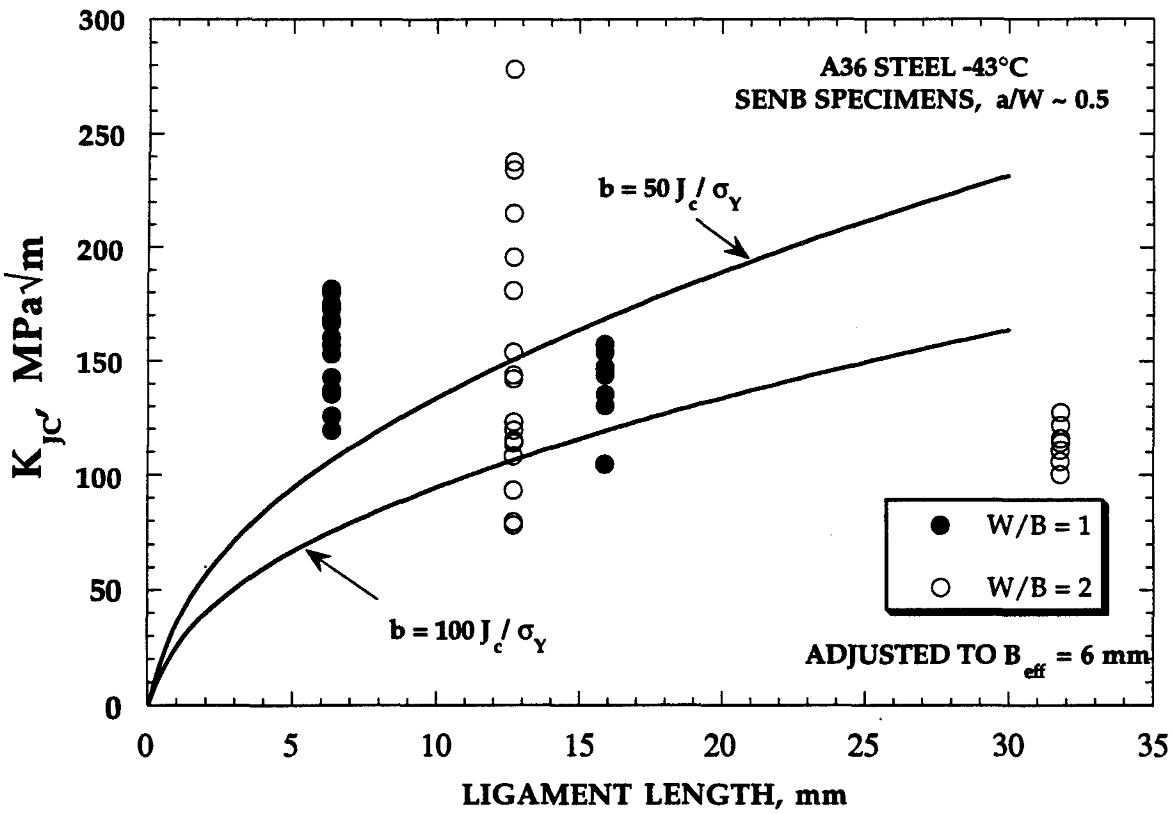


FIGURE 11. **Fracture toughness data for A36 steel at -43°C [15].**

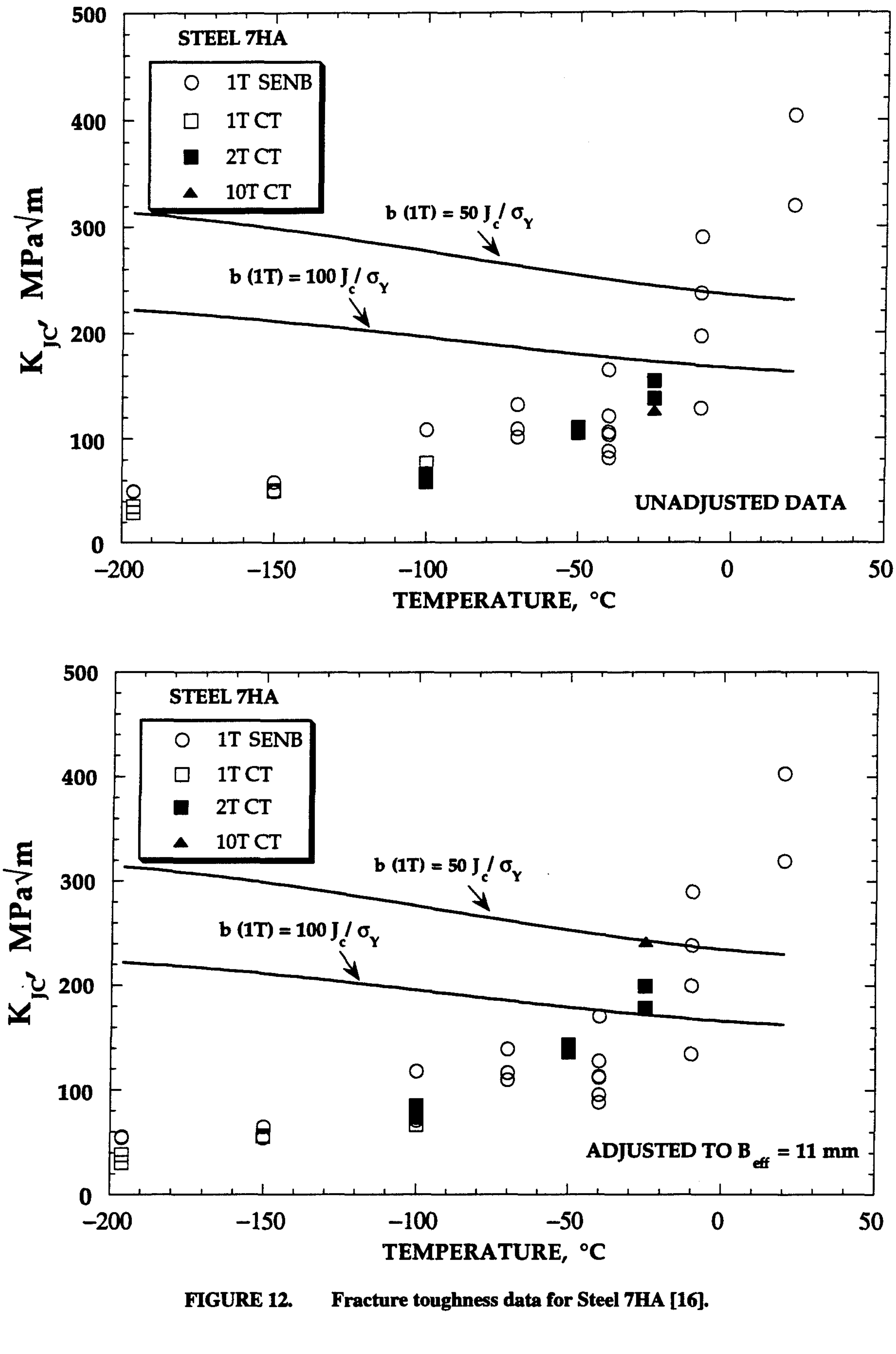


FIGURE 12. **Fracture toughness data for Steel 7HA [16].**

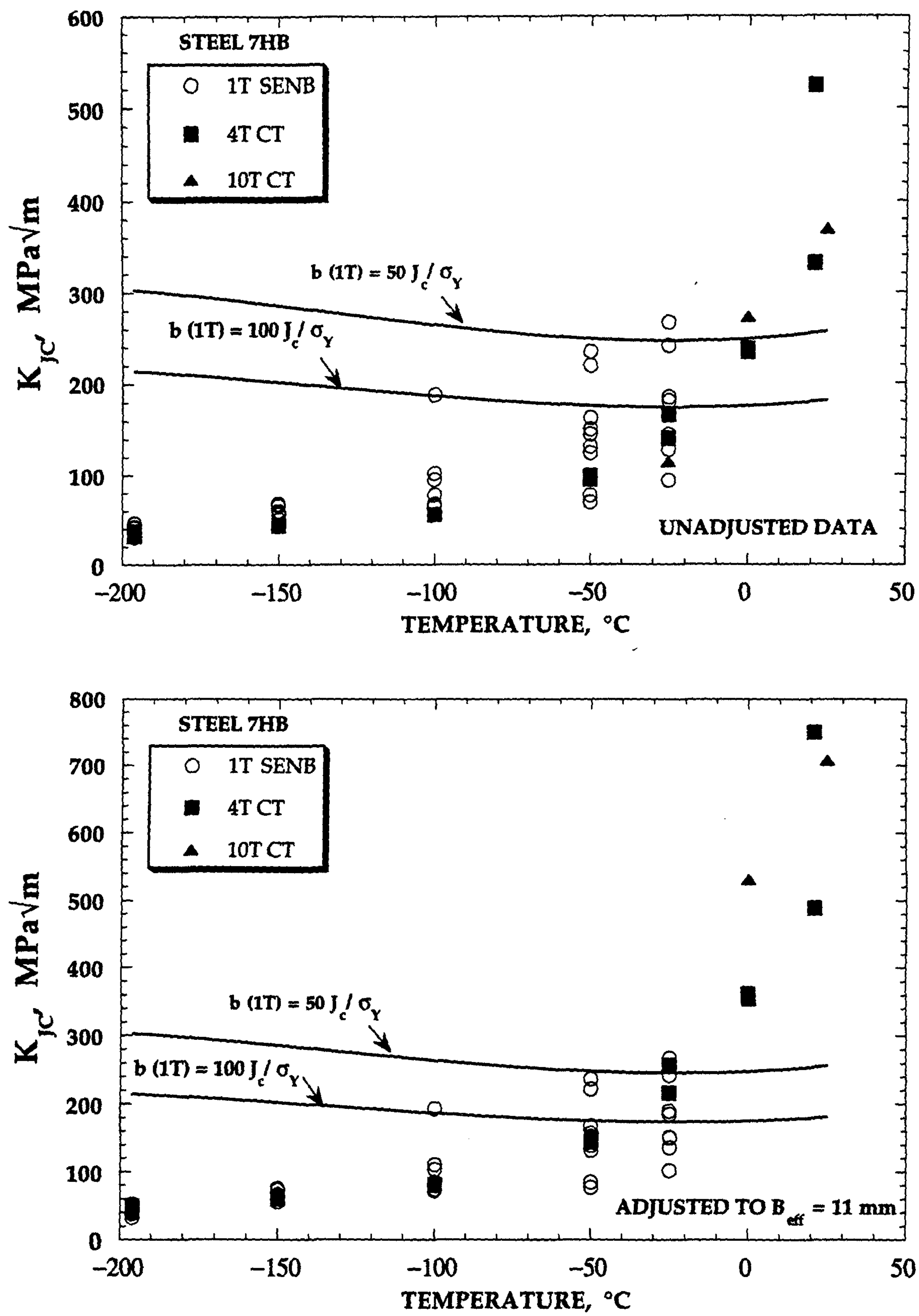


FIGURE 13. Fracture toughness data for Steel 7HB [16].

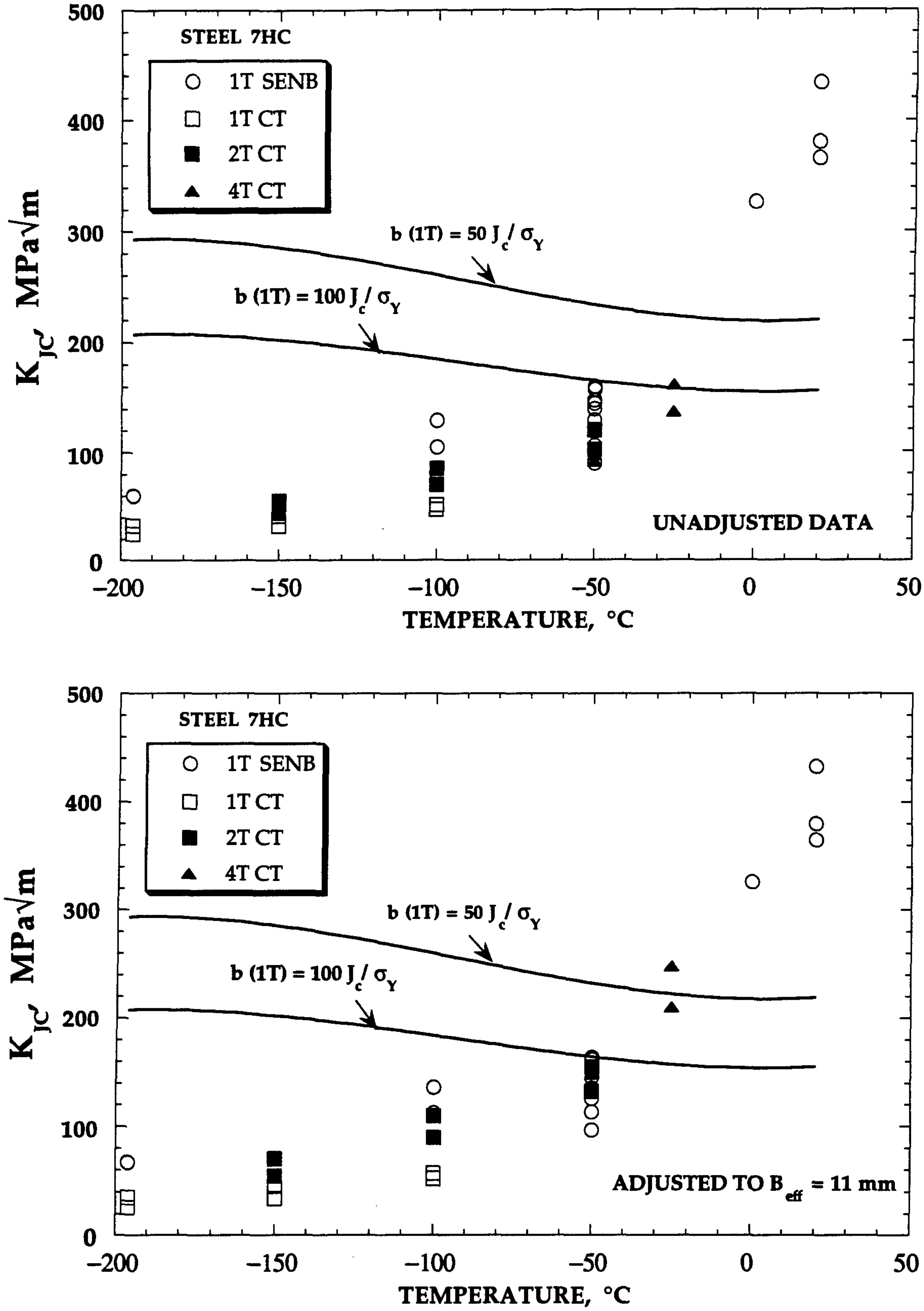


FIGURE 14. **Fracture toughness data for Steel 7HC [16].**

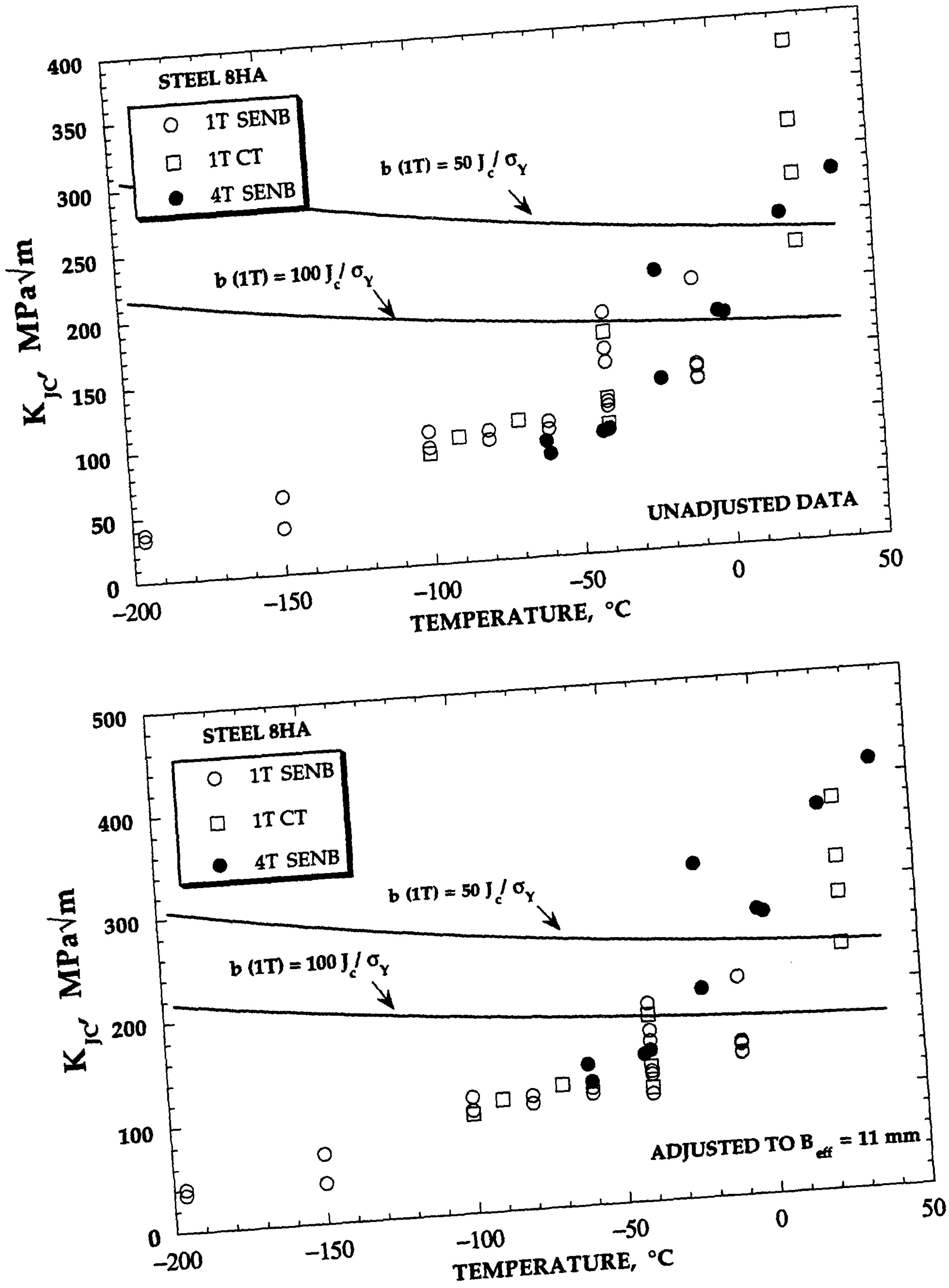


FIGURE 15. Fracture toughness data for Steel 8HA [16].

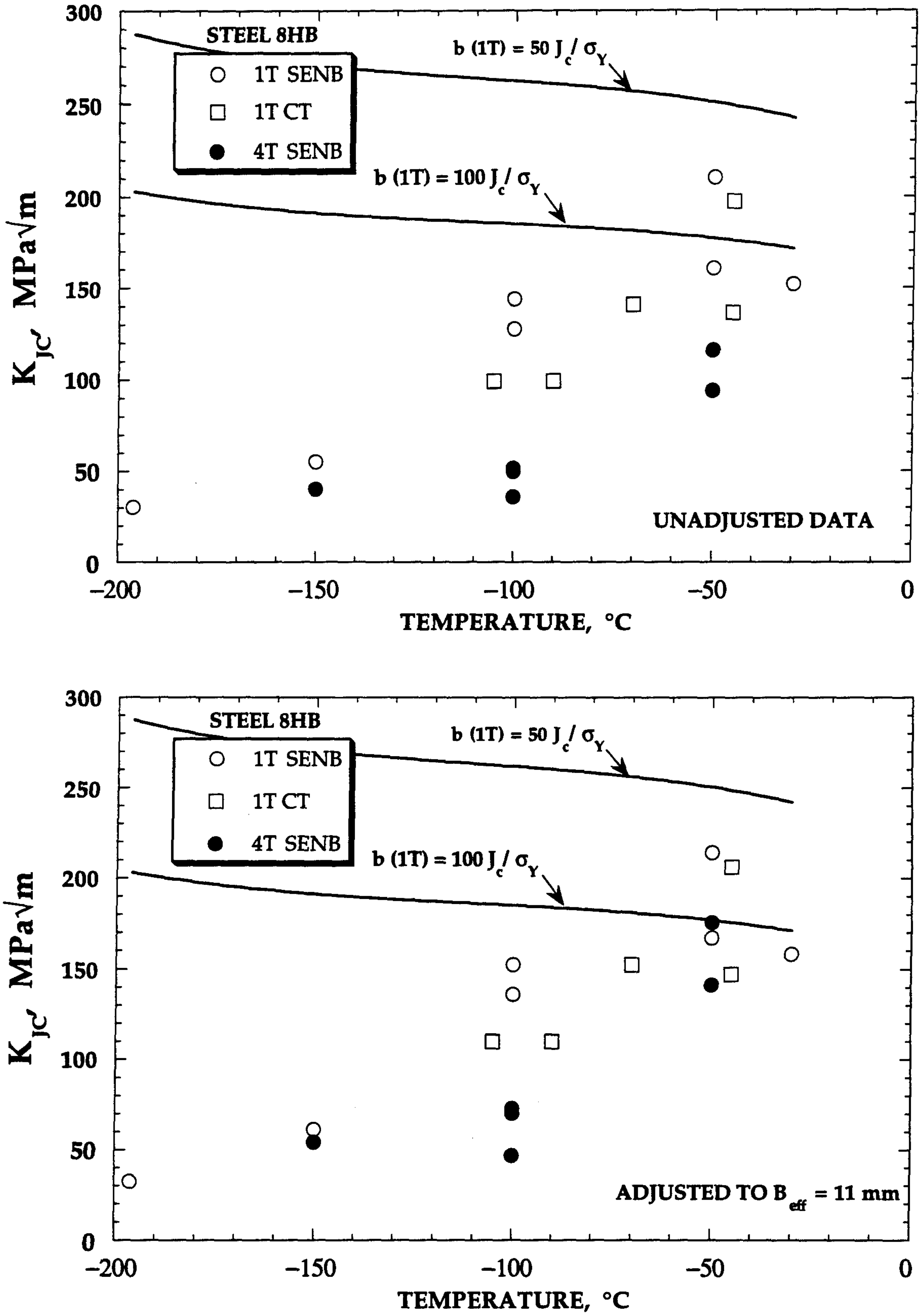
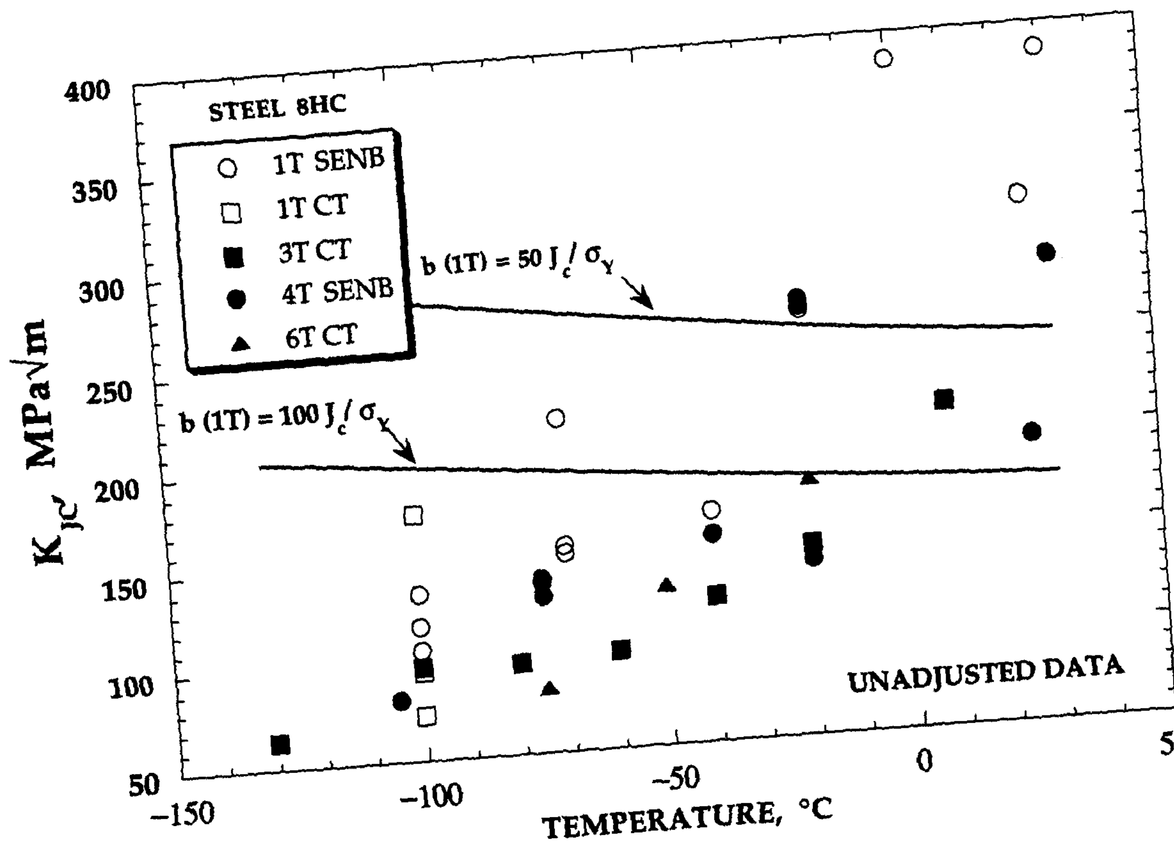


FIGURE 16. Fracture toughness data for Steel 8HB [16].



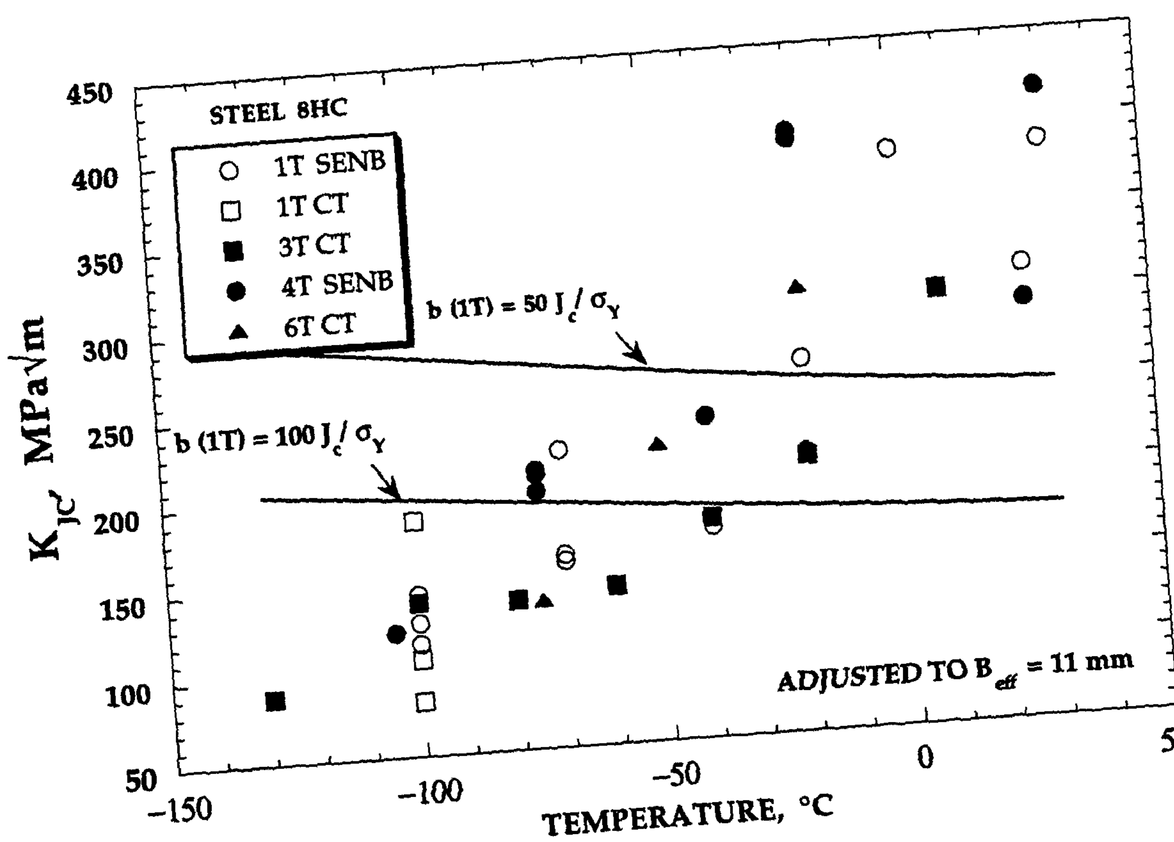


FIGURE 17. Fracture toughness data for Steel 8HC [16].

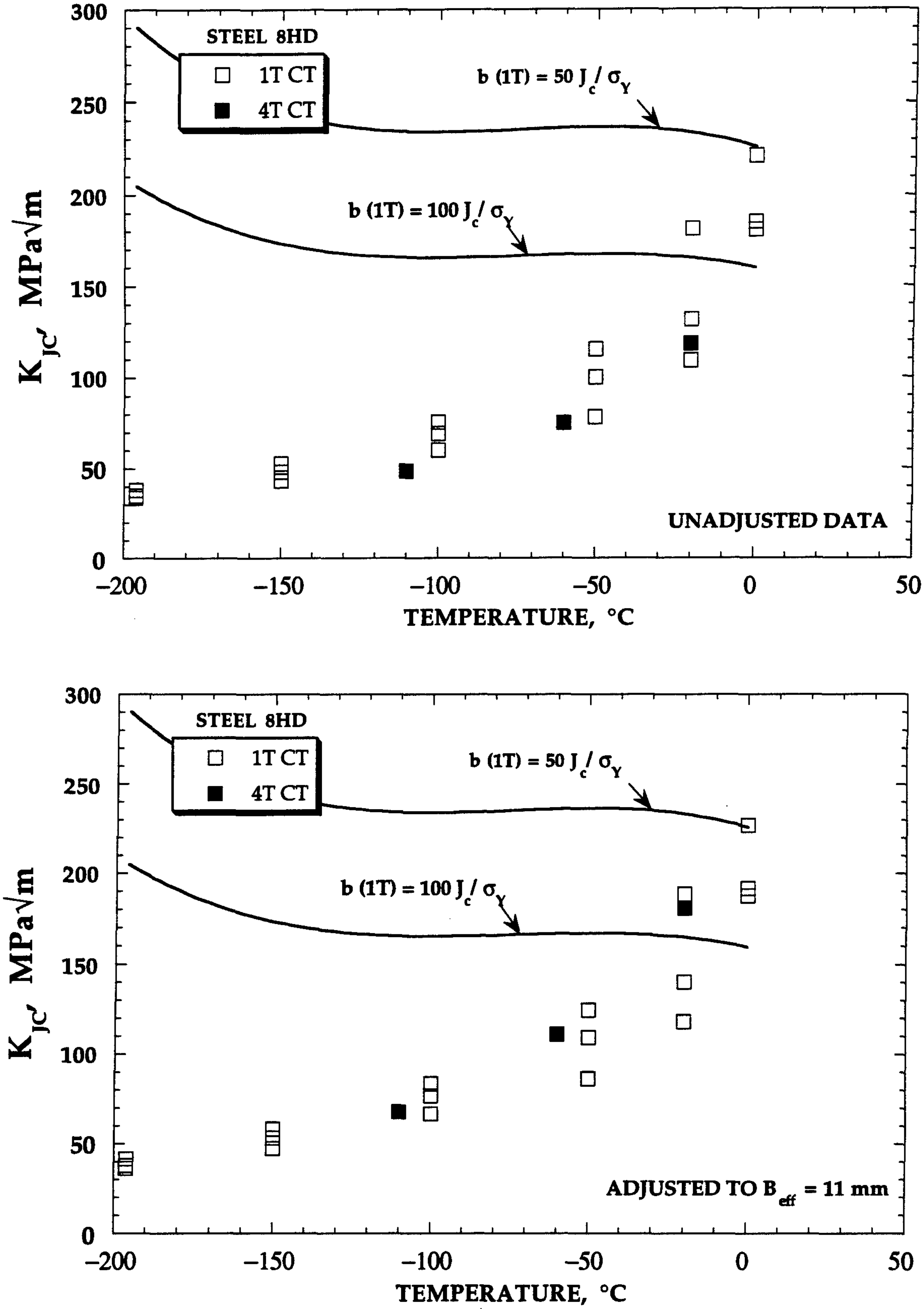


FIGURE 18. Fracture toughness data for Steel 8HD [16].

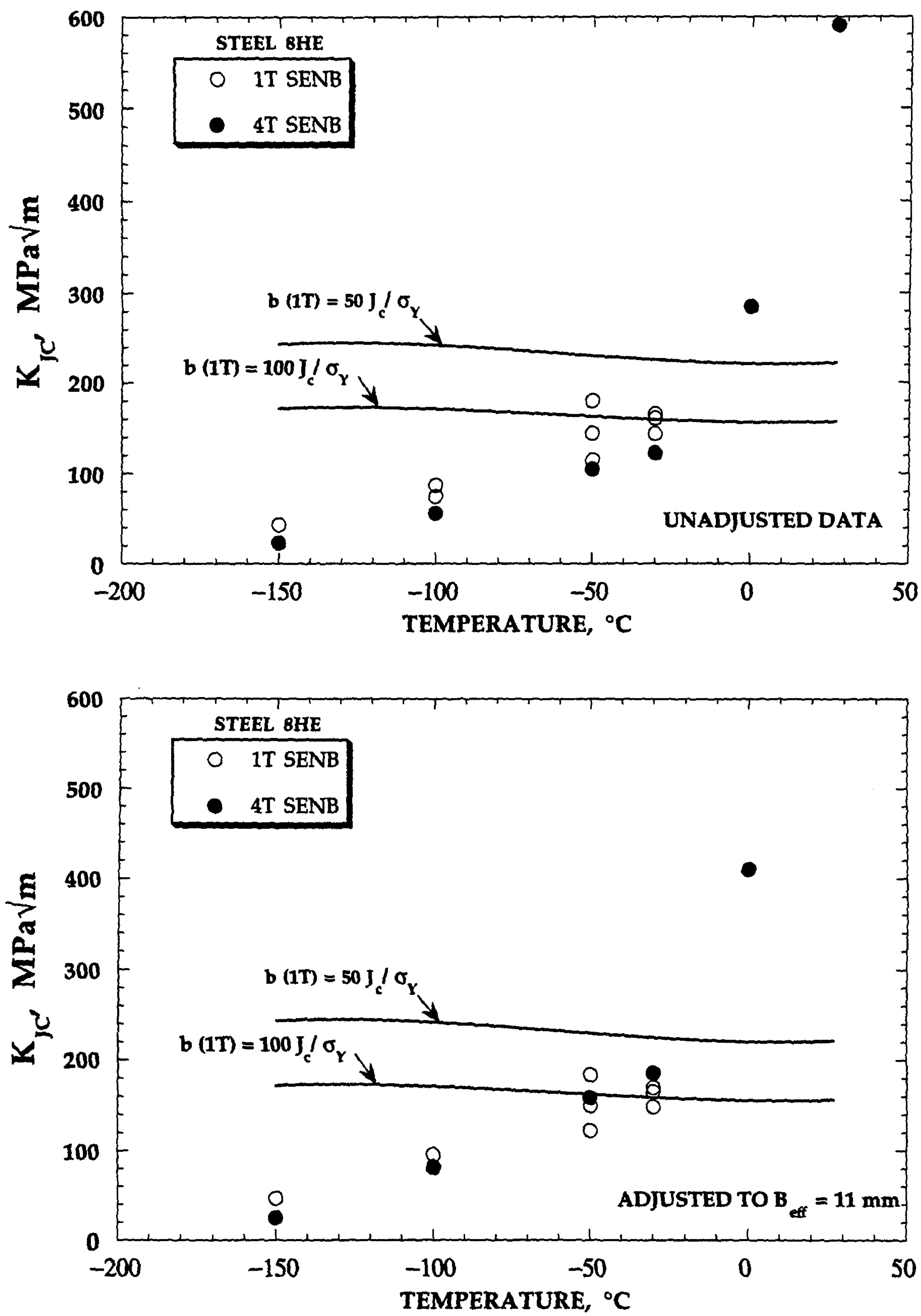
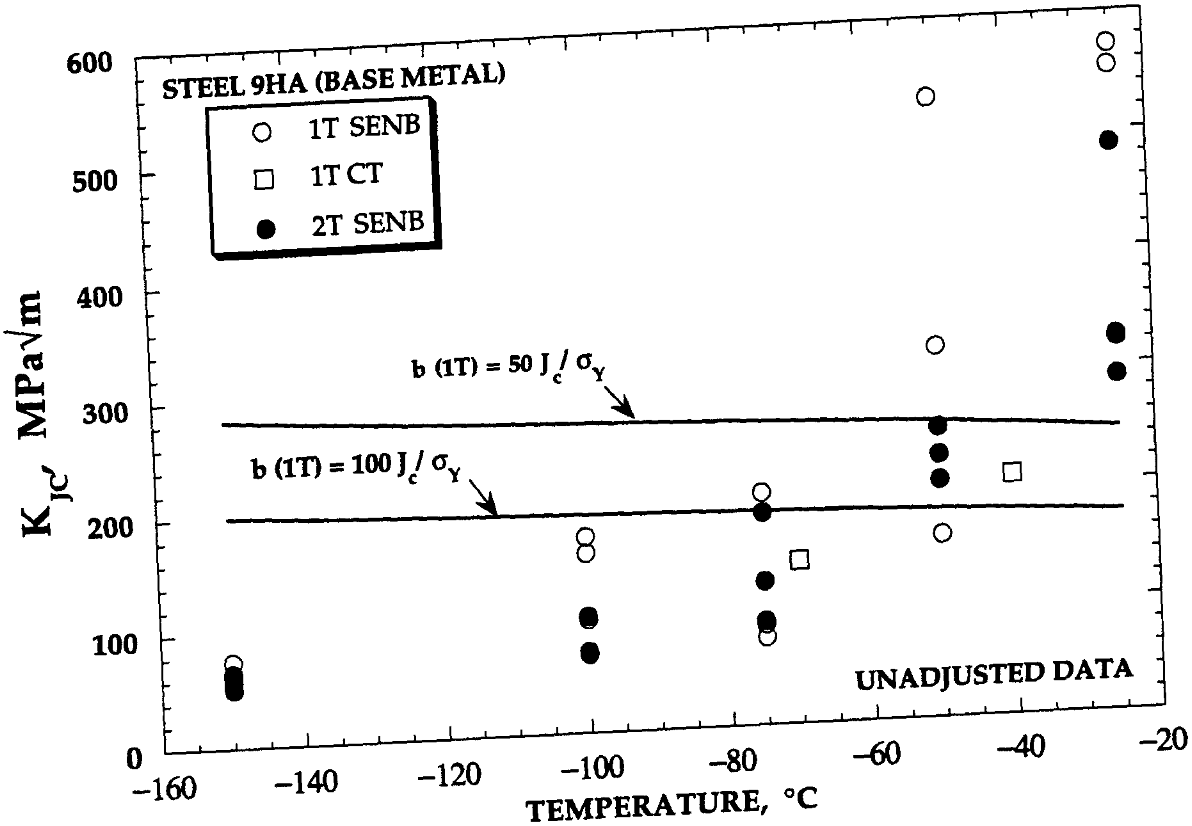


FIGURE 19. Fracture toughness data for Steel 8HE [16].



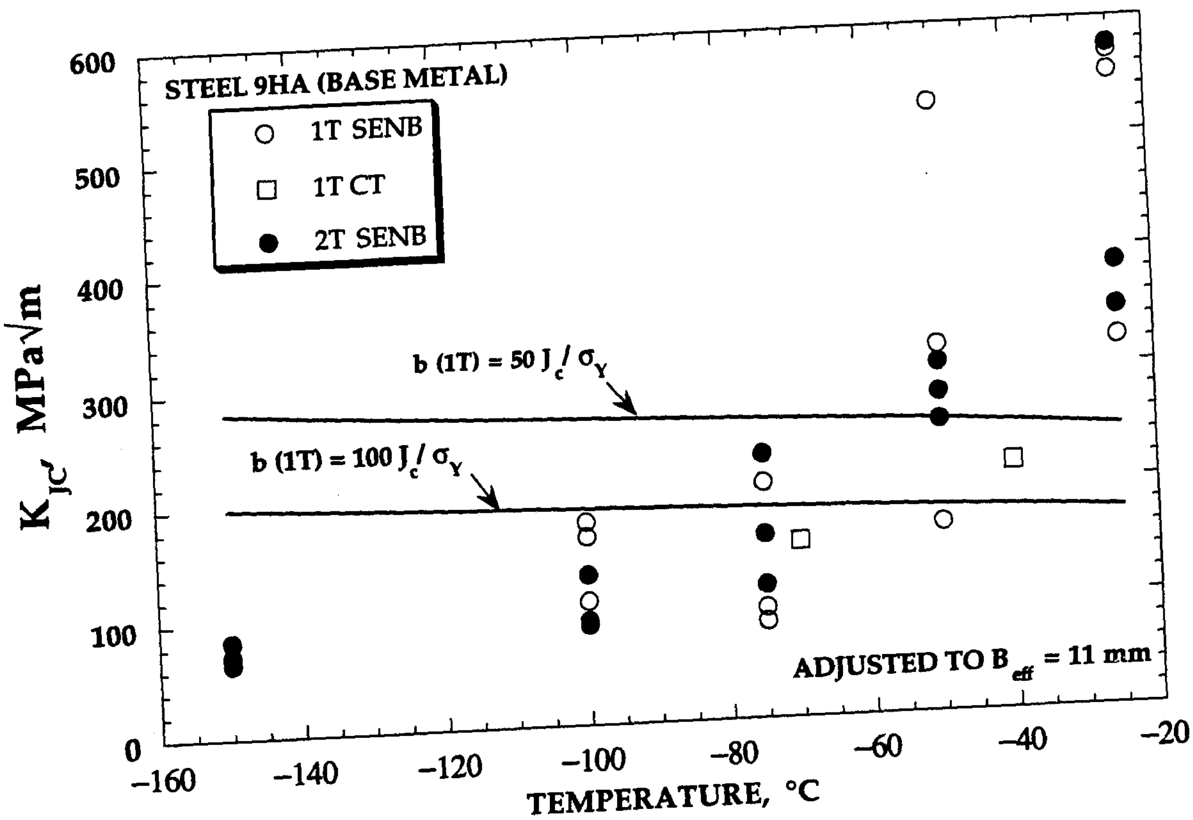


FIGURE 20. Fracture toughness data for Steel 9HA base metal [16].

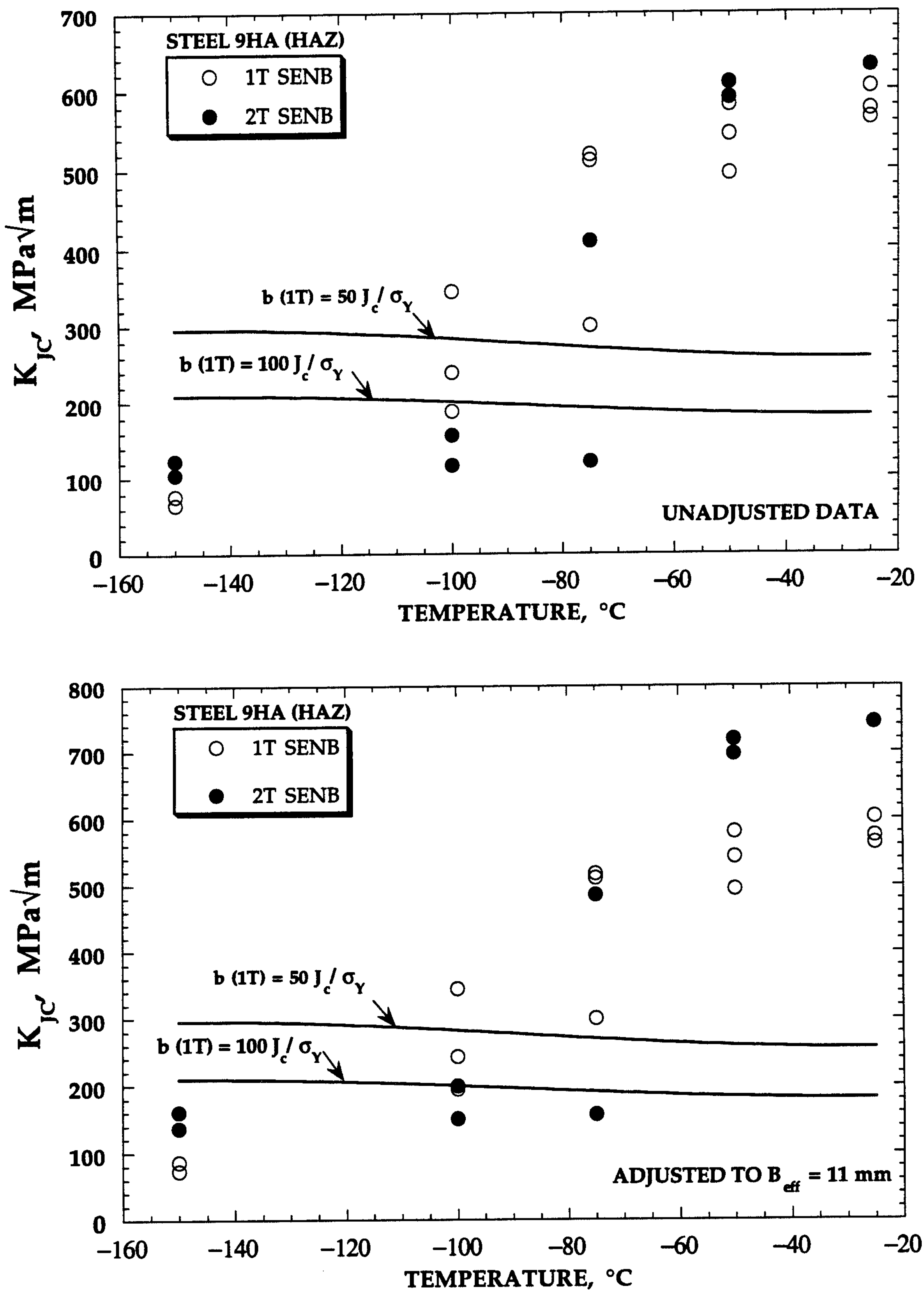


FIGURE 21. Fracture toughness data for Steel 9HA weld HAZ [16].

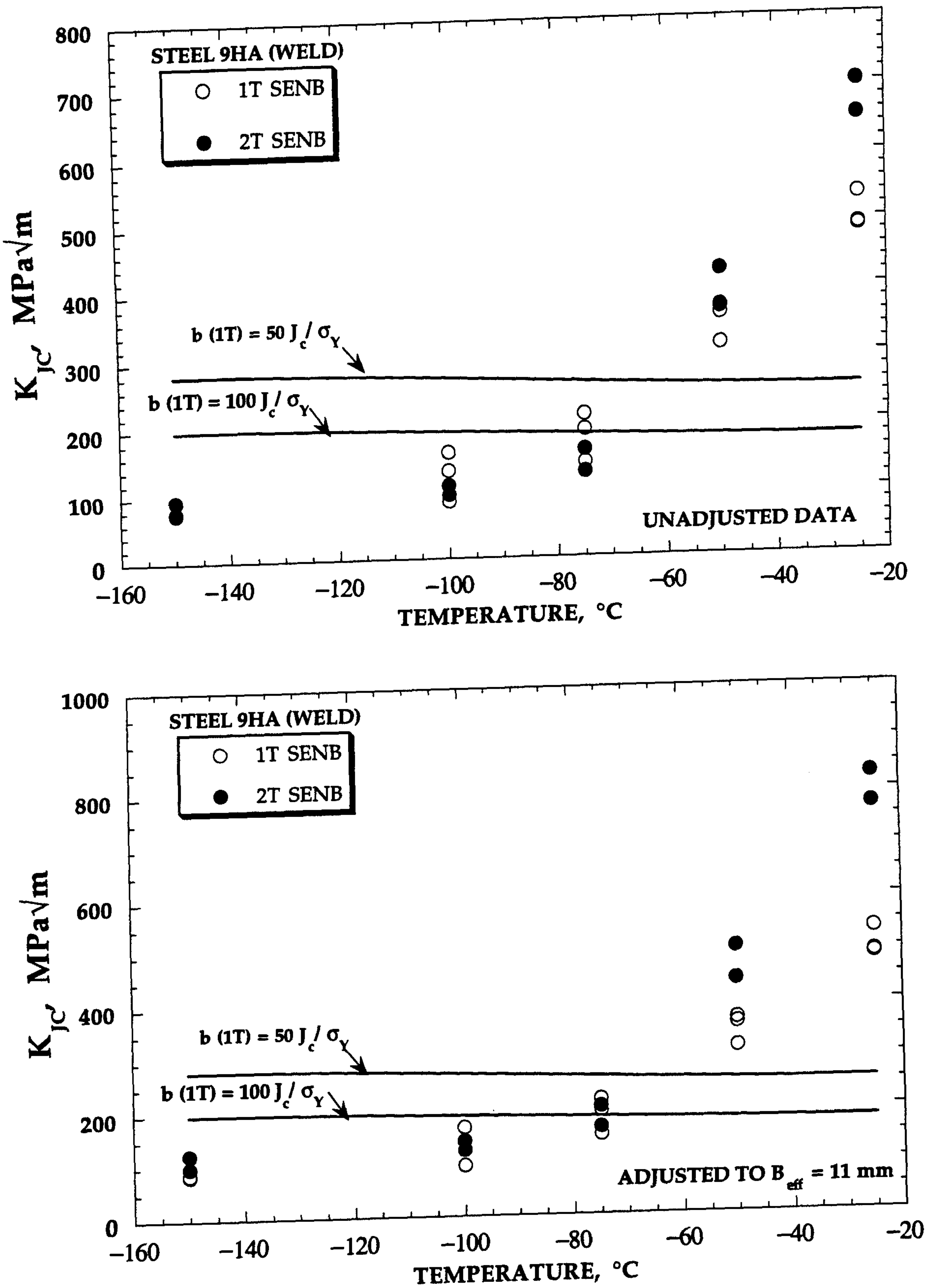


FIGURE 22. Fracture toughness data for Steel 9HA weld metal [16].

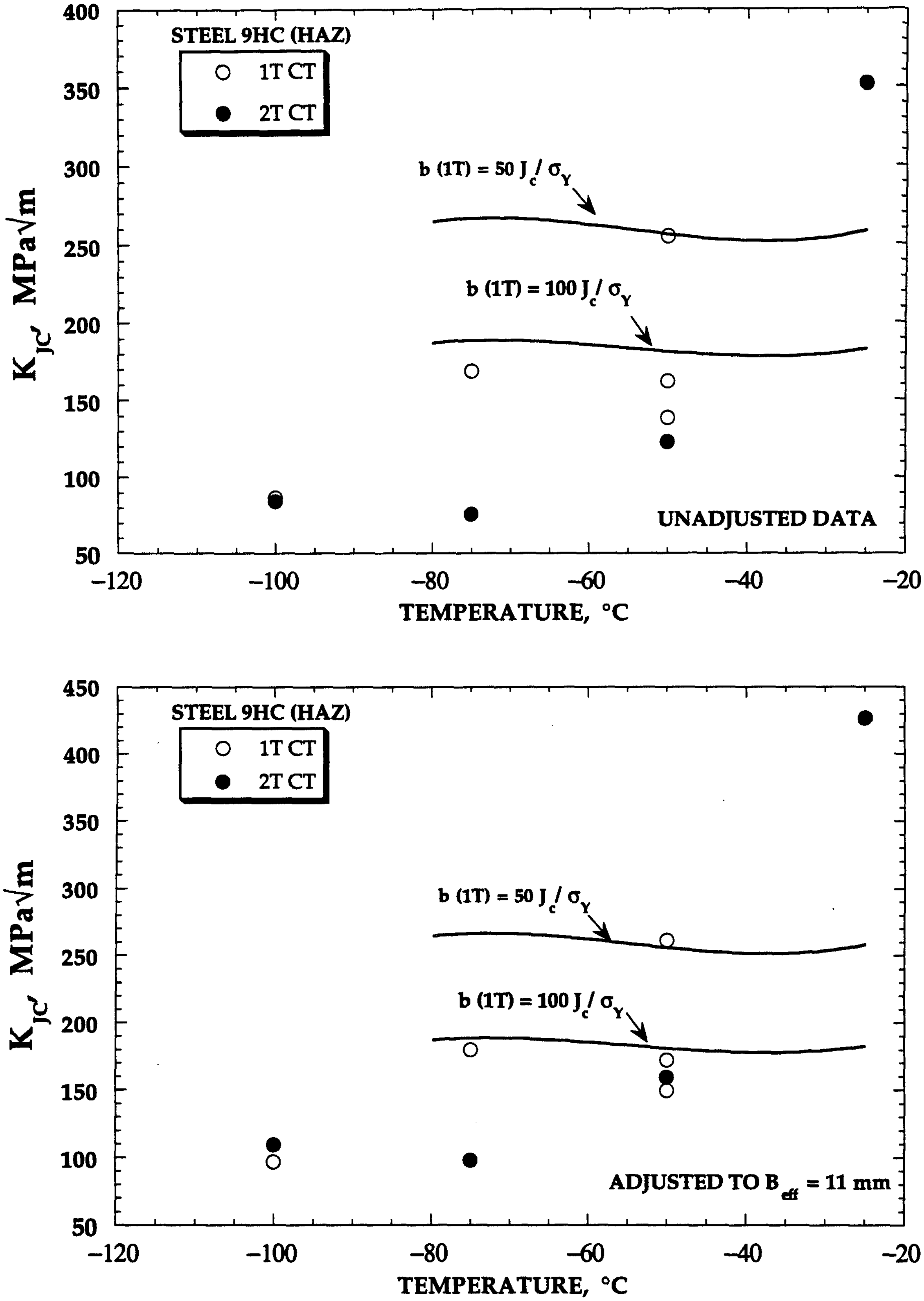


FIGURE 23. Fracture toughness data for Steel 9HC weld HAZ [16].

APPENDIX A. FRACTURE TOUGHNESS DATA FROM THE JAPANESE ROUND ROBIN.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1																	
2																	
3	Material	Orient/locat.	RTNDT (°C)	TEMP (°C)	Specimen type	Size	a/W	Jc	KJC	Yield Strength	Tens. Str.	T-RTNDT	KJC(Beff)	delta a (mm	comments	KJCmax(1T)	b So/J
4	7HA	1/4t - T	-30.00	20.00	SENB	1.00	0.62	720.40	403.68	510.79	648.04	50.00	403.13	1.026	FRACTURE	159.34	13.74
5	7HA	1/4t - T	-30.00	20.00	SENB	1.00	0.61	450.69	319.29	510.79	648.04	50.00	319.31	0.410	FRACTURE	163.93	22.53
6	7HA	1/4t - T	-30.00	-10.00	SENB	1.00	0.61	370.40	289.45	537.26	684.32	20.00	290.03	0.332	FRACTURE	165.74	28.84
7	7HA	1/4t - T	-30.00	-10.00	SENB	1.00	0.61	169.90	196.04	537.26	684.32	20.00	199.90	0.162	FRACTURE	167.66	62.87
8	7HA	1/4t - T	-30.00	-40.00	SENB	1.00	0.60	119.41	164.35	552.95	712.75	-10.00	170.41	0.086	FRACTURE	170.85	94.42
9	7HA	1/4t - T	-30.00	-40.00	SENB	1.00	0.62	49.12	105.41	552.95	712.75	-10.00	113.40	0.037	FRACTURE	166.53	218.08
10	7HA	1/4t - T	-30.00	-40.00	SENB	1.00	0.62	33.92	87.60	552.95	712.75	-10.00	95.38	0.014	FRACTURE	166.53	315.78
11	7HA	1/4t - T	-30.00	-40.00	SENB	1.00	0.62	64.02	120.34	552.95	712.75	-10.00	128.07	0.026	FRACTURE	166.53	167.32
12	7HA	1/4t - T	-30.00	-40.00	SENB	1.00	0.61	29.02	81.02	552.95	712.75	-10.00	88.64	0.014	FRACTURE	168.70	378.83
13	7HA	1/4t - T	-30.00	-40.00	SENB	1.00	0.50		103.20	552.95	712.75	-10.00	112.54	0.071	FRACTURE	193.52	299.36
14	7HA	1/4t - T	-30.00	-70.00	SENB	1.00	0.61	76.37	131.44	576.48	746.08	-40.00	139.25	0.030	FRACTURE	172.45	150.07
15	7HA	1/4t - T	-30.00	-70.00	SENB	1.00	0.61	52.06	108.52	576.48	746.08	-40.00	116.85	0.019	FRACTURE	172.45	220.16
16	7HA	1/4t - T	-30.00	-70.00	SENB	1.00	0.51		100.53	576.48	746.08	-40.00	109.90	0.038	FRACTURE	195.51	322.29
17	7HA	1/4t - T	-30.00	-100.00	SENB	1.00	0.61	19.41	66.25	615.69	776.48	-70.00	73.07	0.000	FRACTURE	176.93	630.94
18	7HA	1/4t - T	-30.00	-100.00	SENB	1.00	0.50	17.94	63.67	615.69	776.48	-70.00	70.62	0.000	FRACTURE	200.34	875.58
19	7HA	1/4t - T	-30.00	-100.00	SENB	1.00	0.50	51.57	107.97	615.69	776.48	-70.00	117.93	0.000	FRACTURE	204.66	304.50
20	7HA	1/4t - T	-30.00	-150.00	SENB	1.00	0.51	15.10	58.44	709.81	837.26	-120.00	64.87	0.000	FRACTURE	209.07	1174.38
21	7HA	1/4t - T	-30.00	-150.00	SENB	1.00	0.50	10.69	49.17	709.81	837.26	-120.00	54.29	0.000	FRACTURE	219.91	1693.07
22	7HA	1/4t - T	-30.00	-196.00	SENB	1.00	0.51	10.59	48.94	884.32	967.65	-166.00	54.13	0.000	FRACTURE	228.74	2086.28
23	7HA	1/4t - T	-30.00	-196.00	SENB	1.00	0.50	10.98	49.85	884.32	967.65	-166.00	55.19	0.000	FRACTURE	212.52	2051.98
24	7HA	2/4t - T	-35.00	-10.00	SENB	1.00	0.61	247.06	236.40	536.28	682.36	25.00	238.42	0.24	FRACTURE	165.54	43.16
25	7HA	2/4t - T	-35.00	-10.00	SENB	1.00	0.62	72.26	127.84	536.28	682.36	25.00	135.11	0.04	FRACTURE	161.09	143.78
26	7HA	1/4t - T	-30.00	20.00	SENB	1.00	0.61	268.83	246.59	510.79	648.04	50.00	248.02	0.20	UNLOADED	161.43	37.78
27	7HA	1/4t - T	-30.00	20.00	SENB	1.00	0.61	229.41	227.80	510.79	648.04	50.00	229.88	0.15	UNLOADED	161.43	44.27
28	7HA	1/4t - T	-30.00	20.00	SENB	1.00	0.61	172.06	197.28	510.79	648.04	50.00	200.71	0.12	UNLOADED	161.43	59.02
29	7HA	1/4t - T	-30.00	20.00	SENB	1.00	0.61	112.16	159.28	510.79	648.04	50.00	164.80	0.05	UNLOADED	161.43	90.55
30	7HA	1/4t - T	-30.00	20.00	SENB	1.00	0.62	91.96	144.23	510.79	648.04	50.00	150.38	0.03	UNLOADED	159.34	107.60
31	7HA	1/4t - T	-30.00	20.00	SENB	1.00	0.61	28.73	80.61	510.79	648.04	50.00	87.96	0.00	UNLOADED	163.93	353.53
32	7HA	1/4t - T	-30.00	-10.00	SENB	1.00	0.60	101.57	151.58	537.26	684.32	20.00	158.11	0.05	UNLOADED	167.85	107.86
33	7HA	1/4t - T	-30.00	-10.00	SENB	1.00	0.61	100.69	150.92	537.26	684.32	20.00	157.29	0.08	UNLOADED	165.74	106.09
34	7HA	1/4t - T	-30.00	-10.00	SENB	1.00	0.61	83.82	137.70	537.26	684.32	20.00	144.74	0.03	UNLOADED	165.74	127.43
35	7HA	1/4t - T	-30.00	-10.00	SENB	1.00	0.62	72.06	127.67	537.26	684.32	20.00	134.96	0.04	UNLOADED	163.60	144.43
36	7HA	1/4t - T	-30.00	-10.00	SENB	1.00	0.61	69.22	125.13	537.26	684.32	20.00	132.68	0.01	UNLOADED	165.74	154.32
37	7HA	1/4t - T	-30.00	-10.00	SENB	1.00	0.61	15.69	59.57	537.26	684.32	20.00	65.52	0.01	UNLOADED	167.66	680.96
38	7HA	1/4t - T	-30.00	-40.00	SENB	1.00	0.61	24.90	75.05	552.95	712.75	-10.00	82.34	0.02	UNLOADED	170.91	441.47
39	7HA	1/4t - T	-30.00	-70.00	SENB	1.00	0.61	37.06	91.56	576.48	746.08	-40.00	99.72	0.02	UNLOADED	172.45	309.27
40	7HA	1/4t - T	-30.00	-70.00	SENB	1.00	0.62	32.16	85.29	576.48	746.08	-40.00	93.14	0.02	UNLOADED	170.23	347.28
41	7HA	1/4t - T	-30.00	-70.00	SENB	1.00	0.61	21.47	69.69	576.48	746.08	-40.00	76.69	0.02	UNLOADED	166.67	533.82
42	7HB	0/4t - T	-50.00	-25.00	SENB	1.00	0.56	255.39	240.33	510.40	658.93	25.00	242.61		FRACTURE	172.24	44.84
43	7HB	1/4t - T	-25.00	-25.00	SENB	1.00	0.59	91.86	144.12	510.40	658.93	0.00	150.84		FRACTURE	166.26	116.19
44	7HB	1/4t - T	-25.00	-25.00	SENB	1.00	0.57	39.02	93.94	510.40	658.93	0.00	102.06		FRACTURE	170.27	286.78
45	7HB	2/4t - T	-25.00	-25.00	SENB	1.00	0.56	72.55	128.07	510.40	658.93	0.00	136.00		FRACTURE	172.24	157.89
46	7HB	2/4t - T	-25.00	-25.00	SENB	1.00	0.56	143.63	180.26	510.40	658.93	0.00	185.53		FRACTURE	172.24	79.70
47	7HB	3/4t - T	-25.00	-25.00	SENB	1.00	0.58	313.43	266.27	510.40	658.93	0.00	267.46		FRACTURE	168.28	34.87
48	7HB	3/4t - T	-25.00	-25.00	SENB	1.00	0.56	150.98	184.83	510.40	658.93	0.00	189.83		FRACTURE	172.24	75.81
49	7HB	1/4t - L	-25.00	-25.00	SENB	1.00	0.56	92.06	144.30	510.40	658.93	0.00	151.55		FRACTURE	173.32	124.38
50	7HB	0/4t - T	-50.00	-50.00	SENB	1.00	0.57	211.67	218.79	526.87	673.73	0.00	222.06		FRACTURE	172.53	54.58
51	7HB	0/4t - T	-50.00	-50.00	SENB	1.00	0.58	242.06	233.98	526.87	673.73	0.00	236.42		FRACTURE	170.51	46.61
52	7HB	1/4t - T	-25.00	-50.00	SENB	1.00	0.57	99.22	149.84	526.87	673.73	-25.00	156.89		FRACTURE	172.53	116.36
53	7HB	1/4t - T	-25.00	-50.00	SENB	1.00	0.58	76.28	131.36	526.87	673.73	-25.00	139.06		FRACTURE	170.51	147.89
54	7HB	2/4t - T	-25.00	-50.00	SENB	1.00	0.56	31.37	69.81	526.87	673.73	-25.00	76.88		FRACTURE	174.52	548.56
55	7HB	2/4t - T	-25.00	-50.00	SENB	1.00	0.56	26.47	77.33	526.87	673.73	-25.00	84.95		FRACTURE	174.52	447.05
56	7HB	3/4t - T	-25.00	-50.00	SENB	1.00	0.58	116.47	162.31	526.87	673.73	-25.00	168.49		FRACTURE	170.51	96.86
57	7HB	3/4t - T	-25.00	-50.00	SENB	1.00	0.57	68.14	124.11	526.87	673.73	-25.00	132.22		FRACTURE	172.53	169.59
58	7HB	1/4t - L	-25.00	-50.00	SENB	1.00	0.55	92.45	144.61	526.87	673.73	-25.00	152.26		FRACTURE	179.71	130.75

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
59	7HB	0/4t - T	-50.00	-100.00	SENB	1.00	0.57	155.79	187.73	577.26	717.85	-50.00	193.41		FRACTURE	179.19	81.22
60	7HB	1/4t - T	-25.00	-100.00	SENB	1.00	0.55	20.20	67.52	577.26	717.85	-75.00	74.61		FRACTURE	183.31	656.98
61	7HB	1/4t - T	-25.00	-100.00	SENB	1.00	0.55	39.90	95.00	577.26	717.85	-75.00	103.84		FRACTURE	183.31	331.92
62	7HB	2/4t - T	-25.00	-100.00	SENB	1.00	0.58	26.57	77.45	577.26	717.85	-75.00	85.20		FRACTURE	177.10	466.08
63	7HB	3/4t - T	-25.00	-100.00	SENB	1.00	0.55	18.82	65.30	577.26	717.85	-75.00	72.17		FRACTURE	183.31	702.54
64	7HB	3/4t - T	-25.00	-100.00	SENB	1.00	0.56	20.39	67.85	577.26	717.85	-75.00	74.92		FRACTURE	181.26	636.29
65	7HB	1/4t - L	-25.00	-100.00	SENB	1.00	0.56	46.18	102.23	577.26	717.85	-75.00	111.16		FRACTURE	187.29	280.23
66	7HB	0/4t - T	-50.00	-150.00	SENB	1.00	0.57	16.08	60.25	681.18	805.40	-100.00	66.73		FRACTURE	191.98	930.43
67	7HB	1/4t - T	-25.00	-150.00	SENB	1.00	0.55	14.12	56.56	681.18	805.40	-125.00	62.62		FRACTURE	196.39	1104.86
68	7HB	1/4t - T	-25.00	-150.00	SENB	1.00	0.56		60.09	681.18	805.40	-125.00	66.58		FRACTURE	194.20	957.08
69	7HB	2/4t - T	-25.00	-150.00	SENB	1.00	0.58	20.69	68.22	681.18	805.40	-125.00	75.54		FRACTURE	189.74	708.98
70	7HB	3/4t - T	-25.00	-150.00	SENB	1.00	0.54	15.59	59.34	681.18	805.40	-125.00	65.79		FRACTURE	198.57	1026.05
71	7HB	3/4t - T	-25.00	-150.00	SENB	1.00	0.56	19.41	66.33	681.18	805.40	-125.00	73.54		FRACTURE	194.20	785.55
72	7HB	1/4t - L	-25.00	-150.00	SENB	1.00	0.57	11.57	51.04	681.18	805.40	-125.00	56.31		FRACTURE	205.47	1296.51
73	7HB	0/4t - T	-50.00	-196.00	SENB	1.00	0.58	9.71	46.82	959.03	1021.58	-146.00	51.64		FRACTURE	219.00	2118.95
74	7HB	1/4t - T	-25.00	-196.00	SENB	1.00	0.56		42.40	959.03	1021.58	-171.00	46.50		FRACTURE	224.16	2707.27
75	7HB	1/4t - T	-25.00	-196.00	SENB	1.00	0.56	6.76	41.44	959.03	1021.58	-171.00	45.39		FRACTURE	224.16	2833.04
76	7HB	2/4t - T	-25.00	-196.00	SENB	1.00	0.56	5.88	36.39	959.03	1021.58	-171.00	39.45		FRACTURE	224.16	3675.04
77	7HB	3/4t - T	-25.00	-196.00	SENB	1.00	0.56	9.51	46.29	959.03	1021.58	-171.00	51.04		FRACTURE	224.16	2270.68
78	7HB	3/4t - T	-25.00	-196.00	SENB	1.00	0.56	5.49	35.24	959.03	1021.58	-171.00	38.10		FRACTURE	224.16	3918.16
79	7HB	1/4t - L	-25.00	-196.00	SENB	1.00	0.56	4.22	30.70	959.03	1021.58	-171.00	32.74		FRACTURE	202.47	5162.13
80	7HC	2/4t - T	-20.00	-50.00	SENB	1.00	0.62	111.18	158.58	500.00	656.87	-30.00	163.79	0.04	FRACTURE	159.21	87.12
81	7HC	2/4t - T	-20.00	-50.00	SENB	1.00	0.62	95.39	146.89	500.00	656.87	-30.00	152.67		FRACTURE	158.37	100.47
82	7HC	2/4t - T	-20.00	-50.00	SENB	1.00	0.61	91.37	143.77	500.00	656.87	-30.00	149.94		FRACTURE	160.87	108.24
83	7HC	2/4t - T	-20.00	-50.00	SENB	1.00	0.62	62.06	118.48	500.00	656.87	-30.00	125.57	0.02	FRACTURE	158.37	154.44
84	7HC	2/4t - T	-20.00	-50.00	SENB	1.00	0.62	61.67	118.11	500.00	656.87	-30.00	125.24	0.03	FRACTURE	154.15	156.24
85	7HC	2/4t - T	-20.00	20.00	SENB	1.00	0.62	830.59	433.45	442.16	590.20	40.00	432.79	1.43	FRACTURE	149.60	10.20
86	7HC	2/4t - T	-20.00	20.00	SENB	1.00	0.59	639.02	380.20	442.16	590.20	40.00	379.70	0.70	FRACTURE	156.03	14.43
87	7HC	1/4t - T	-20.00	20.00	SENB	1.00	0.62	590.20	365.38	442.16	590.20	40.00	364.91	0.69	FRACTURE	152.66	14.51
88	7HC	1/4t - T	-20.00	0.00	SENB	1.00	0.64	470.59	326.26	450.00	621.57	20.00	325.97	0.33	FRACTURE	152.42	17.74
89	7HC	1/4t - T	-20.00	-50.00	SENB	1.00	0.61	107.94	156.26	500.00	656.87	-30.00	161.71	0.03	FRACTURE	160.46	91.15
90	7HC	1/4t - T	-20.00	-50.00	SENB	1.00	0.62	85.00	138.66	500.00	656.87	-30.00	144.93	0.03	FRACTURE	159.00	113.65
91	7HC	1/4t - T	-20.00	-50.00	SENB	1.00	0.60	72.75	128.28	500.00	656.87	-30.00	135.35		FRACTURE	162.73	139.11
92	7HC	1/4t - T	-20.00	-50.00	SENB	1.00	0.62	49.31	105.62	500.00	656.87	-30.00	113.03	0.03	FRACTURE	158.58	194.87
93	7HC	1/4t - T	-20.00	-50.00	SENB	1.00	0.63	35.20	89.23	500.00	656.87	-30.00	96.56	0.00	FRACTURE	160.52	267.96
94	7HC	1/4t - T	-20.00	-100.00	SENB	1.00	0.62	72.75	128.28	555.89	707.85	-80.00	135.72	0.00	FRACTURE	165.74	146.86
95	7HC	1/4t - T	-20.00	-100.00	SENB	1.00	0.62	48.14	104.35	555.89	707.85	-80.00	112.43	0.00	FRACTURE	185.54	226.06
96	7HC	1/4t - T	-20.00	-196.00	SENB	1.00	0.62	16.08	60.31	939.22	999.03	-176.00	67.01	0.00	FRACTURE	205.53	1125.66
97	7HC	1/4t - T	-20.00	-196.00	SENB	1.00	0.63	15.88	59.94	939.22	999.03	-176.00	66.57	0.00	FRACTURE	180.63	1115.44
98	7HC	2/4t - T	-20.00	20.00	SENB	1.00	0.63	367.85	288.46	442.16	590.20	40.00	288.50	0.22	UNLOADED	149.20	22.92
99	7HC	2/4t - T	-20.00	20.00	SENB	1.00	0.64	109.12	157.11	442.16	590.20	40.00	161.20	0.04	UNLOADED	146.99	74.99
100	7HC	2/4t - T	-20.00	20.00	SENB	1.00	0.63	10.59	48.94	442.16	590.20	40.00	53.45	0.00	UNLOADED	149.20	796.19
101	7HC	2/4t - T	-20.00	20.00	SENB	1.00	0.61	2.75	24.92	442.16	590.20	40.00	25.83	0.00	UNLOADED	157.00	3194.20
102	7HC	2/4t - T	-20.00	-50.00	SENB	1.00	0.62	25.78	76.37	500.00	656.87	-30.00	83.36	0.00	UNLOADED	158.58	372.69
103	7HC	2/4t - T	-20.00	-50.00	SENB	1.00	0.63	10.98	49.84	500.00	656.87	-30.00	54.56	0.00	UNLOADED	152.30	856.59
104	7HC	1/4t - T	-20.00	20.00	SENB	1.00	0.62	937.36	460.47	442.16	590.20	40.00	459.75	1.25	UNLOADED	151.19	9.23
105	7HC	1/4t - T	-20.00	20.00	SENB	1.00	0.62	701.18	398.26	442.16	590.20	40.00	397.68	0.87	UNLOADED	149.60	12.09
106	7HC	1/4t - T	-20.00	20.00	SENB	1.00	0.62	211.86	218.92	442.16	590.20	40.00	220.45		UNLOADED	150.20	40.32
107	7HC	1/4t - T	-20.00	20.00	SENB	1.00	0.63	112.55	159.56	442.16	590.20	40.00	163.72	0.04	UNLOADED	149.20	74.90
108	7HC	1/4t - T	-20.00	20.00	SENB	1.00	0.62	44.90	100.78	442.16	590.20	40.00	107.64		UNLOADED	150.00	189.76
109	7HC	1/4t - T	-20.00	20.00	SENB	1.00	0.62	13.63	55.52	442.16	590.20	40.00	60.77	0.00	UNLOADED	151.19	635.17
110	7HC	1/4t - T	-20.00	20.00	SENB	1.00	0.61	12.06	52.23	442.16	590.20	40.00	57.15	0.00	UNLOADED	151.97	725.27
111	7HC	1/4t - T	-20.00	20.00	SENB	1.00	0.63	3.24	27.05	442.16	590.20	40.00	28.34	0.00	UNLOADED	150.85	2584.82
112	7HC	1/4t - T	-20.00	0.00	SENB	1.00	0.62	361.77	286.06	450.00	621.57	20.00	286.18	0.23	UNLOADED	152.62	23.91
113	7HC	1/4t - T	-20.00	0.00	SENB	1.00	0.62	265.49	245.06	450.00	621.57	20.00	245.90	0.12	UNLOADED	152.62	32.58
114	7HC	1/4t - T	-20.00	0.00	SENB	1.00	0.62	135.49	175.07	450.00	621.57	20.00	178.54	0.05	UNLOADED	152.42	63.66
115	7HC	1/4t - T	-20.00	0.00	SENB	1.00	0.63	35.78	89.97	450.00	621.57	20.00	96.91	0.00	UNLOADED	151.81	239.12
116	7HC	1/4t - T	-20.00	0.00	SENB	1.00	0.63	11.18	50.28	450.00	621.57	20.00	54.96	0.00	UNLOADED	151.60	763.56

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
117	7HC	1/4t - T	-20.00	0.00	SENB	1.00	0.62	7.45	41.05	450.00	621.57	20.00	44.57	0.00	UNLOADED	154.91	1157.66
118	7HC	1/4t - T	-20.00	-50.00	SENB	1.00	0.63	106.37	155.12	500.00	656.87	-30.00	160.32	0.04	UNLOADED	157.10	88.66
119	7HC	1/4t - T	-20.00	-50.00	SENB	1.00	0.62	32.84	86.19	500.00	656.87	-30.00	93.53	0.00	UNLOADED	158.37	291.81
120	7HC	1/4t - T	-20.00	-50.00	SENB	1.00	0.63	9.02	45.17	500.00	656.87	-30.00	49.30	0.00	UNLOADED	156.46	1037.15
121	7HC	1/4t - T	-20.00	-50.00	SENB	1.00	0.61	8.53	43.92	500.00	656.87	-30.00	47.92	0.00	UNLOADED	164.17	1156.53
122	7HC	1/4t - T	-20.00	-100.00	SENB	1.00	0.62	41.96	97.43	555.89	707.85	-80.00	105.48	0.00	UNLOADED	167.27	259.34
123	7HC	1/4t - T	-20.00	-100.00	SENB	1.00	0.63	15.10	58.44	555.89	707.85	-80.00	64.27	0.00	UNLOADED	183.36	703.86
124	7HC	1/4t - T	-20.00	-196.00	SENB	1.00	0.63	7.84	42.12	939.22	999.03	-176.00	46.12	0.00	UNLOADED	203.35	2258.77
125	7HC	1/4t - T	-20.00	-196.00	SENB	1.00	0.62	5.49	35.24	939.22	999.03	-176.00	38.07	0.00	UNLOADED	193.15	3287.86
126	7HA		-30.00	-100.00	CT	1.00	0.53		60.14	616.00	777.00	-70.00	66.84		FRACTURE	195.12	930.94
127	7HA		-30.00	-100.00	CT	1.00	0.52		75.95	616.00	777.00	-70.00	84.73		FRACTURE	200.95	593.56
128	7HA		-30.00	-150.00	CT	1.00	0.52		50.53	710.00	837.00	-120.00	55.84		FRACTURE	206.49	1532.77
129	7HA		-30.00	-150.00	CT	1.00	0.51		50.22	710.00	837.00	-120.00	55.49		FRACTURE	218.18	1597.20
130	7HA		-30.00	-196.00	CT	1.00	0.52		35.03	884.00	968.00	-166.00	37.75		FRACTURE	227.34	4020.75
131	7HA		-30.00	-196.00	CT	1.00	0.52		29.14	884.00	968.00	-166.00	30.81		FRACTURE	215.30	5810.43
132	7HA		-30.00	-100.00	CT	2.00	0.52		58.59	616.00	777.00	-70.00	73.99		FRACTURE	195.53	1969.97
133	7HA		-30.00	-100.00	CT	2.00	0.52		66.03	616.00	777.00	-70.00	84.27		FRACTURE	191.96	1557.56
134	7HA		-30.00	-50.00	CT	2.00	0.52		109.74	558.00	721.00	-20.00	143.05		FRACTURE	188.73	516.14
135	7HA		-30.00	-50.00	CT	2.00	0.52		105.09	558.00	721.00	-20.00	136.91		FRACTURE	186.44	559.34
136	7HA		-30.00	-25.00	CT	2.00	0.51		137.02	545.00	698.00	5.00	178.20		FRACTURE	187.78	329.39
137	7HA		-30.00	-25.00	CT	2.00	0.52		154.07	545.00	698.00	5.00	199.35		FRACTURE	185.86	255.23
138	7HA		-30.00	-25.00	CT	10.00	0.54		126.17	545.00	698.00	5.00	241.96		FRACTURE	176.88	1800.27
139	7HB		-25.00	0.00	CT	4.00	0.51		233.12	495.00	645.00	25.00	355.39		FRACTURE	178.73	204.19
140	7HB		-25.00	0.00	CT	4.00	0.51		237.77	495.00	645.00	25.00	362.01		FRACTURE	177.25	196.48
141	7HB		-25.00	21.00	CT	4.00	0.52		331.39	485.00	625.00	46.00	489.46		FRACTURE	176.09	98.70
142	7HB		-25.00	21.00	CT	4.00	0.51		523.59	485.00	625.00	46.00	750.67		FRACTURE	180.60	40.35
143	7HB		-25.00	-25.00	CT	4.00	0.52		140.12	510.00	659.00	0.00	216.43		FRACTURE	180.43	578.72
144	7HB		-25.00	-25.00	CT	4.00	0.51		166.16	510.00	659.00	0.00	256.85		FRACTURE	182.24	414.52
145	7HB		-25.00	-50.00	CT	4.00	0.52		94.55	527.00	674.00	-25.00	143.58		FRACTURE	183.17	1317.44
146	7HB		-25.00	-50.00	CT	4.00	0.51		99.20	527.00	674.00	-25.00	151.15		FRACTURE	187.07	1204.24
147	7HB		-25.00	-100.00	CT	4.00	0.52		56.42	577.00	718.00	-75.00	80.83		FRACTURE	190.20	4050.91
148	7HB		-25.00	-100.00	CT	4.00	0.52		56.11	577.00	718.00	-75.00	80.31		FRACTURE	195.27	4045.08
149	7HB		-25.00	-150.00	CT	4.00	0.52		43.71	681.00	805.00	-125.00	59.67		FRACTURE	203.53	7949.35
150	7HB		-25.00	-150.00	CT	4.00	0.52		44.64	681.00	805.00	-125.00	61.23		FRACTURE	216.19	7503.35
151	7HB		-25.00	-196.00	CT	4.00	0.51		32.86	959.00	1022.00	-171.00	41.54		FRACTURE	235.97	19971.36
152	7HB		-25.00	-196.00	CT	4.00	0.52		37.82	959.00	1022.00	-171.00	49.84		FRACTURE	209.70	14890.92
153	7HB		-25.00	25.00	CT	10.00	0.54		368.90	485.00	625.00	50.00	707.90		FRACTURE	173.83	190.61
154	7HB		-25.00	0.00	CT	10.00	0.53		272.18	495.00	645.00	25.00	531.39		FRACTURE	176.01	358.75
155	7HB		-25.00	-25.00	CT	10.00	0.53		114.39	510.00	659.00	0.00	217.58		FRACTURE	182.18	2124.11
156	7HC		-25.00	-100.00	CT	1.00	0.52		51.77	556.00	708.00	-75.00	57.18		FRACTURE	186.25	1138.71
157	7HC		-25.00	-100.00	CT	1.00	0.50		47.43	556.00	708.00	-75.00	52.18		FRACTURE	199.17	1425.04
158	7HC		-25.00	-150.00	CT	1.00	0.52		41.54	661.00	820.00	-125.00	45.35		FRACTURE	202.45	2120.31
159	7HC		-25.00	-150.00	CT	1.00	0.53		31.93	661.00	820.00	-125.00	34.08		FRACTURE	212.55	3528.87
160	7HC		-25.00	-196.00	CT	1.00	0.52		32.86	939.00	999.00	-171.00	35.20		FRACTURE	232.56	4853.62
161	7HC		-25.00	-196.00	CT	1.00	0.52		24.80	939.00	999.00	-171.00	25.68		FRACTURE	210.17	8450.71
162	7HC		-25.00	-50.00	CT	2.00	0.52		119.35	500.00	657.00	-25.00	155.12		FRACTURE	179.32	390.20
163	7HC		-25.00	-50.00	CT	2.00	0.51		101.99	500.00	657.00	-25.00	132.55		FRACTURE	184.17	539.89
164	7HC		-25.00	-100.00	CT	2.00	0.52		70.06	556.00	708.00	-75.00	89.74		FRACTURE	186.65	1248.77
165	7HC		-25.00	-100.00	CT	2.00	0.54		84.94	556.00	708.00	-75.00	109.94		FRACTURE	192.07	826.46
166	7HC		-25.00	-150.00	CT	2.00	0.52		44.64	661.00	820.00	-125.00	54.59		FRACTURE	202.67	3679.75
167	7HC		-25.00	-150.00	CT	2.00	0.51		55.80	661.00	820.00	-125.00	70.15		FRACTURE	190.94	2379.52
168	7HC		-25.00	-25.00	CT	4.00	0.52		136.40	480.00	640.00	0.00	210.31		FRACTURE	176.61	574.79
169	7HC		-25.00	-25.00	CT	4.00	0.51		160.89	480.00	640.00	0.00	248.40		FRACTURE	179.41	419.97
170	7HC		-25.00	-50.00	CT	4.00	0.51		91.14	500.00	657.00	-25.00	137.98		FRACTURE	181.44	1370.21
171	7HC		-25.00	-50.00	CT	4.00	0.51		97.34	500.00	657.00	-25.00	148.06		FRACTURE	118.79	1191.49

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1																	
2																	
3	Material	Orient/locat.	RTNDT (°C)	TEMP (°C)	Specimen type	Size	a/W	Jc	KJC	Yield Strength	Tens. Str.	T-RTNDT	KJC(Beff)	delta a (mm)	comments	KJCmax(1T)	b So/J
4	8HA	1/4t - T	-35.00	-10.00	SENB	1.00	0.51	185.10	204.62	463.73	607.85	25.00	208.60	0.12	FRACTURE	173.64	62.33
5	8HA	1/4t - T	-35.00	-10.00	SENB	1.00	0.53	84.12	137.94	463.73	607.85	25.00	145.23	0.05	FRACTURE	170.01	131.47
6	8HA	1/4t - T	-35.00	-10.00	SENB	1.00	0.52	74.31	129.65	463.73	607.85	25.00	137.49	0.05	FRACTURE	172.50	153.20
7	8HA	1/4t - T	-35.00	-10.00	SENB	1.00	0.52	73.63	129.05	463.73	607.85	25.00	136.92	0.06	FRACTURE	172.71	155.02
8	8HA	1/4t - T	-35.00	-10.00	SENB	1.00	0.53	86.77	140.09	463.73	607.85	25.00	147.38	0.07	FRACTURE	168.97	129.09
9	8HA	1/4t - T	-35.00	-40.00	SENB	1.00	0.53	107.94	156.26	498.04	581.38	-5.00	163.23	0.09	FRACTURE	171.07	110.60
10	8HA	1/4t - T	-35.00	-40.00	SENB	1.00	0.52	149.12	183.66	498.04	581.38	-5.00	189.17	0.11	FRACTURE	172.01	80.94
11	8HA	1/4t - T	-35.00	-40.00	SENB	1.00	0.52	39.51	94.54	498.04	581.38	-5.00	103.01	0.04	FRACTURE	172.41	306.91
12	8HA	1/4t - T	-35.00	-40.00	SENB	1.00	0.52	59.51	116.02	498.04	581.38	-5.00	124.64	0.05	FRACTURE	172.91	204.96
13	8HA	1/4t - T	-35.00	-40.00	SENB	1.00	0.52	94.22	145.99	498.04	581.38	-5.00	153.60	0.08	FRACTURE	172.41	128.71
14	8HA	1/4t - T	-35.00	-40.00	SENB	1.00	0.52	56.18	112.73	498.04	581.38	-5.00	121.37	0.05	FRACTURE	181.23	216.85
15	8HA	1/4t - T	-35.00	-60.00	SENB	1.00	0.53	47.65	103.82	513.73	689.22	-25.00	112.56		FRACTURE	181.32	260.54
16	8HA	1/4t - T	-35.00	-60.00	SENB	1.00	0.53	42.55	98.11	513.73	689.22	-25.00	106.74		FRACTURE	183.10	290.64
17	8HA	1/4t - T	-35.00	-80.00	SENB	1.00	0.52	38.24	93.00	531.38	717.65	-45.00	101.69		FRACTURE	185.69	339.22
18	8HA	1/4t - T	-35.00	-80.00	SENB	1.00	0.53	44.22	100.01	531.38	717.65	-45.00	108.79		FRACTURE	184.80	286.48
19	8HA	1/4t - T	-35.00	-100.00	SENB	1.00	0.52	46.37	102.42	554.91	735.30	-65.00	111.53		FRACTURE	188.18	290.37
20	8HA	1/4t - T	-35.00	-100.00	SENB	1.00	0.53	35.78	89.97	554.91	735.30	-65.00	98.64		FRACTURE	191.36	372.18
21	8HA	1/4t - T	-35.00	-150.00	SENB	1.00	0.53		60.33	676.48	794.12	-115.00	66.91		FRACTURE	199.63	1007.47
22	8HA	1/4t - T	-35.00	-150.00	SENB	1.00	0.52		36.18	676.48	794.12	-115.00	39.16		FRACTURE	212.66	2884.84
23	8HA	1/4t - T	-35.00	-196.00	SENB	1.00	0.54		33.08	927.46	944.13	-161.00	35.55		FRACTURE	223.77	4535.76
24	8HA	1/4t - T	-35.00	-196.00	SENB	1.00	0.52		37.36	927.46	944.13	-161.00	40.60		FRACTURE	206.13	3678.98
25	8HA	1/4t - T	-35.00	38.00	SENB	4.00	0.52	349.71	281.26	470.59	607.85	73.00	412.46		FRACTURE	174.54	132.40
26	8HA	1/4t - T	-35.00	20.00	SENB	4.00	0.51	276.08	249.90	479.42	624.51	55.00	371.04		FRACTURE	178.94	174.57
27	8HA	1/4t - T	-35.00	0.00	SENB	4.00	0.51	139.90	177.89	498.04	647.06	35.00	270.39		FRACTURE	179.50	354.25
28	8HA	1/4t - T	-35.00	-2.00	SENB	4.00	0.52	142.65	179.63	498.04	647.06	33.00	272.67		FRACTURE	177.65	340.32
29	8HA	1/4t - T	-35.00	-22.00	SENB	4.00	0.51	75.39	130.59	500.00	647.06	13.00	199.73		FRACTURE	179.28	657.26
30	8HA	1/4t - T	-35.00	-22.00	SENB	4.00	0.51	200.39	212.91	500.00	647.06	13.00	320.43		FRACTURE	181.66	247.53
31	8HA	1/4t - T	-35.00	-40.00	SENB	4.00	0.52	40.10	95.24	509.81	676.48	-5.00	144.38		FRACTURE	182.04	1250.92
32	8HA	1/4t - T	-35.00	-42.00	SENB	4.00	0.52	38.43	93.24	509.81	681.38	-7.00	141.19		FRACTURE	183.11	1311.94
33	8HA	1/4t - T	-35.00	-60.00	SENB	4.00	0.51	27.65	79.08	522.55	689.22	-25.00	118.39		FRACTURE	184.65	1880.84
34	8HA	1/4t - T	-35.00	-61.00	SENB	4.00	0.51	35.20	89.23	522.55	689.22	-26.00	134.84		FRACTURE	174.26	1488.02
35	8HA	1/4t - T	-35.00	-10.00	SENB	1.00	0.52	152.06	185.46	481.38	549.02	25.00	190.60	0.09	UNLOADED	168.20	76.85
36	8HA	1/4t - T	-35.00	-10.00	SENB	1.00	0.52	123.04	166.83	481.38	549.02	25.00	173.03	0.07	UNLOADED	168.13	94.90
37	8HA	1/4t - T	-35.00	-10.00	SENB	1.00	0.53	245.00	235.41	481.38	549.02	25.00	237.92	0.15	UNLOADED	166.92	46.98
38	8HA	1/4t - T	-35.00	-10.00	SENB	1.00	0.52	17.06	62.12	481.38	549.02	25.00	68.47		UNLOADED	168.20	685.04
39	8HA	1/4t - T	-35.00	-10.00	SENB	1.00	0.52	44.80	100.67	481.38	549.02	25.00	109.10		UNLOADED	171.00	261.37
40	8HA	1/4t - T	-35.00	-40.00	SENB	1.00	0.53	95.79	147.20	498.04	581.38	-5.00	154.65	0.05	UNLOADED	171.29	124.95
41	8HA	1/4t - T	-35.00	-40.00	SENB	1.00	0.52	64.90	121.17	498.04	581.38	-5.00	129.66	0.04	UNLOADED	172.37	186.76
42	8HA	1/4t - T	-35.00	-40.00	SENB	1.00	0.53	19.12	65.76	498.04	581.38	-5.00	72.51		UNLOADED	171.58	628.18
43	8HA	1/4t - T	-35.00	-40.00	SENB	1.00	0.53	33.73	87.34	498.04	581.38	-5.00	95.47		UNLOADED	176.00	350.22
44	8HB	1/4t - T	-30.00	-30.00	SENB	1.00	0.59	101.67	151.65	531.38	656.87	0.00	158.30		FRACTURE	167.68	109.35
45	8HB	1/4t - T	-30.00	-30.00	SENB	1.00	0.58			531.38	656.87				FRACTURE	171.56	
46	8HB	1/4t - T	-30.00	-50.00	SENB	1.00	0.57	113.73	160.39	550.00	672.55	-20.00	167.15		FRACTURE	173.37	105.13
47	8HB	1/4t - T	-30.00	-50.00	SENB	1.00	0.59	195.69	210.39	550.00	672.55	-20.00	214.10		FRACTURE	174.61	59.18
48	8HB	1/4t - T	-30.00	-100.00	SENB	1.00	0.57	91.47	143.84	620.59	730.40	-70.00	152.49		FRACTURE	183.44	149.42
49	8HB	1/4t - T	-30.00	-100.00	SENB	1.00	0.58	71.57	127.24	620.59	730.40	-70.00	136.21		FRACTURE	188.72	185.93
50	8HB	1/4t - T	-30.00	-150.00	SENB	1.00	0.58	13.53	55.32	772.56	848.05	-120.00	61.28		FRACTURE	208.01	1233.10
51	8HB	1/4t - T	-30.00	-196.00	SENB	1.00	0.57	4.12	30.52	983.34	999.03	-166.00	32.52		FRACTURE	201.77	5191.14
52	8HB	1/4t - T	-30.00	-50.00	SENB	4.00	0.61	38.73	93.59	550.00	672.55	-20.00	141.38		FRACTURE	169.17	1122.69
53	8HB	1/4t - T	-30.00	-100.00	SENB	4.00	0.61	11.76	51.59	620.59	730.40	-70.00	73.09		FRACTURE	182.48	4230.05
54	8HB	1/4t - T	-30.00	-150.00	SENB	4.00	0.61	7.16	40.24	772.56	848.05	-120.00	54.15		FRACTURE	180.38	8595.64
55	8HB	3/4t - T	-30.00	-50.00	SENB	4.00	0.61	58.92	115.45	550.00	672.55	-20.00	175.67		FRACTURE	168.90	735.49
56	8HB	3/4t - T	-30.00	-100.00	SENB	4.00	0.62	10.98	49.84	620.59	730.40	-70.00	70.16		FRACTURE	180.03	4411.18
57	8HB	3/4t - T	-30.00	-100.00	SENB	4.00	0.61	5.69	35.86	772.56	848.05	-70.00	46.80		FRACTURE	176.10	10718.92
58	8HC	1/4t - T	-35.00	30.00	SENB	1.00	0.55	657.85	385.75	475.49	617.65	65.00	385.34	0.71	FRACTURE	168.79	16.51

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
59	8HC	1/4t - T	-35.00	25.00	SENB	1.00	0.55	434.32	313.44	480.40	627.46	60.00	313.71	0.33	FRACTURE	169.92	25.49
60	8HC	1/4t - T	-35.00	0.00	SENB	1.00	0.55	654.91	384.89	495.10	627.46	35.00	384.51	0.73	FRACTURE	172.85	17.19
61	8HC	1/4t - T	-35.00	-20.00	SENB	1.00	0.55	309.81	264.72	509.81	666.67	15.00	266.27	0.21	FRACTURE	176.16	37.75
62	8HC	1/4t - T	-35.00	-40.00	SENB	1.00	0.56	122.55	166.50	524.51	686.28	-5.00	172.86		FRACTURE	178.54	96.88
63	8HC	1/4t - T	-35.00	-70.00	SENB	1.00	0.55	211.77	218.87	563.73	720.59	-35.00	222.98		FRACTURE	182.55	61.07
64	8HC	1/4t - T	-35.00	-70.00	SENB	1.00	0.55	100.00	150.40	563.73	720.59	-35.00	158.25		FRACTURE	181.73	128.17
65	8HC	1/4t - T	-35.00	-70.00	SENB	1.00	0.55	104.90	154.04	563.73	720.59	-35.00	161.72		FRACTURE	197.68	122.18
66	8HC	1/4t - T	-35.00	-100.00	SENB	1.00	0.55	80.39	134.85	622.55	955.89	-65.00	144.16		FRACTURE	202.82	178.44
67	8HC	1/4t - T	-35.00	-100.00	SENB	1.00	0.56	50.00	106.35	622.55	955.89	-65.00	115.74		FRACTURE	201.02	281.83
68	8HC	1/4t - T	-35.00	-100.00	SENB	1.00	0.55	61.77	118.20	622.55	955.89	-65.00	127.74		FRACTURE	179.74	231.23
69	8HC	1/4t - T	-35.00	30.00	SENB	4.00	0.52	354.90	283.34	480.40	622.55	65.00	415.73		FRACTURE	175.56	133.18
70	8HC	1/4t - T	-35.00	25.00	SENB	4.00	0.52	166.67	194.17	480.40	627.46	60.00	293.27		FRACTURE	179.10	285.06
71	8HC	1/4t - T	-35.00	-20.00	SENB	4.00	0.52	313.73	266.39	509.81	666.67	15.00	394.40		FRACTURE	181.38	160.71
72	8HC	1/4t - T	-35.00	-20.00	SENB	4.00	0.52	85.29	138.90	509.81	666.67	15.00	212.47		FRACTURE	180.44	585.03
73	8HC	1/4t - T	-35.00	-20.00	SENB	4.00	0.52	321.57	269.70	509.81	666.67	15.00	398.64		FRACTURE	181.94	155.18
74	8HC	1/4t - T	-35.00	-40.00	SENB	4.00	0.52	105.88	154.76	524.51	686.28	-5.00	236.57		FRACTURE	185.51	482.34
75	8HC	1/4t - T	-35.00	-75.00	SENB	4.00	0.52	82.35	136.49	568.63	725.50	-40.00	209.51		FRACTURE	189.65	678.66
76	8HC	1/4t - T	-35.00	-75.00	SENB	4.00	0.52	84.31	138.10	568.63	725.50	-40.00	211.96		FRACTURE	189.25	660.12
77	8HC	1/4t - T	-35.00	-75.00	SENB	4.00	0.52	74.51	129.82	568.63	725.50	-40.00	199.26		FRACTURE	206.81	754.76
78	8HC	1/4t - T	-35.00	-105.00	SENB	4.00	0.52	29.41	81.57	627.46	960.79	-70.00	122.69		FRACTURE	188.17	2088.11
79	8HC	1/4t - T	-35.00	0.00	SENB	1.00	0.56	650.01	383.45	495.10	651.97	35.00	383.06		UNLOADED	170.20	17.01
80	8HC	1/4t - T	-35.00	0.00	SENB	1.00	0.55	538.24	348.93	495.10	651.97	35.00	348.82		UNLOADED	171.75	20.91
81	8HC	1/4t - T	-35.00	0.00	SENB	1.00	0.54	396.08	299.32	495.10	651.97	35.00	299.96		UNLOADED	174.04	29.19
82	8HC	1/4t - T	-35.00	0.00	SENB	1.00	0.56	245.10	235.46	495.10	651.97	35.00	237.69		UNLOADED	170.90	44.90
83	8HC	1/4t - T	-35.00	-20.00	SENB	1.00	0.55	251.96	238.73	509.81	666.67	15.00	241.20		UNLOADED	174.71	46.42
84	8HC	1/4t - T	-35.00	-20.00	SENB	1.00	0.55	191.18	207.95	509.81	666.67	15.00	211.82		UNLOADED	174.33	60.90
85	8HC	1/4t - T	-35.00	-20.00	SENB	1.00	0.55	120.59	165.16	509.81	666.67	15.00	171.44		UNLOADED	172.21	96.55
86	8HE	1/4t - T	-30.00	-30.00	SENB	1.00	0.63	121.08	165.49	500.00	638.24	0.00	170.14		FRACTURE	156.12	78.19
87	8HE	1/4t - T	-30.00	-30.00	SENB	1.00	0.62	90.69	143.23	500.00	638.24	0.00	149.23		FRACTURE	158.64	106.13
88	8HE	1/4t - T	-30.00	-50.00	SENB	1.00	0.61	143.04	179.88	522.55	655.89	-20.00	184.33		FRACTURE	161.95	71.89
89	8HE	1/4t - T	-30.00	-50.00	SENB	1.00	0.63	58.43	114.97	522.55	655.89	-20.00	122.29		FRACTURE	162.32	167.59
90	8HE	1/4t - T	-30.00	-100.00	SENB	1.00	0.63	24.71	74.76	606.87	720.59	-70.00	82.11		FRACTURE	167.83	460.82
91	8HE	1/4t - T	-30.00	-100.00	SENB	1.00	0.63	33.73	87.34	606.87	720.59	-70.00	95.33		FRACTURE	162.19	336.11
92	8HE	3/4t - T	-30.00	-30.00	SENB	1.00	0.62	113.82	160.46	500.00	638.24	0.00	165.54		FRACTURE	158.93	84.87
93	8HE	3/4t - T	-30.00	-50.00	SENB	1.00	0.64	91.77	144.07	522.55	655.89	-20.00	150.03		FRACTURE	160.86	104.80
94	8HE	3/4t - T	-30.00	-100.00	SENB	1.00	0.65	24.90	75.05	606.87	720.59	-70.00	82.28		FRACTURE	171.11	431.60
95	8HE	3/4t - T	-30.00	-150.00	SENB	1.00	0.64	8.14	42.90	796.08	854.91	-120.00	46.95		FRACTURE	170.98	1807.42
96	8HE	1/4t - T	-30.00	27.00	SENB	4.00	0.61	1540.50	590.31	456.87	602.95	57.00	826.87		FRACTURE	156.19	23.81
97	8HE	1/4t - T	-30.00	0.00	SENB	4.00	0.61	355.98	283.77	474.51	617.65	30.00	411.03		FRACTURE	157.66	105.30
98	8HE	1/4t - T	-30.00	-30.00	SENB	4.00	0.61	66.47	122.62	500.00	638.24	0.00	186.19		FRACTURE	160.46	592.62
99	8HE	1/4t - T	-30.00	-50.00	SENB	4.00	0.61	48.63	104.88	522.55	655.89	-20.00	159.01		FRACTURE	166.60	848.58
100	8HE	1/4t - T	-30.00	-100.00	SENB	4.00	0.60	14.02	56.31	606.87	720.59	-70.00	80.93		FRACTURE	182.66	3494.13
101	8HE	1/4t - T	-30.00	-150.00	SENB	4.00	0.61	2.35	23.07	796.08	854.91	-120.00	25.20		FRACTURE	172.83	26965.52
102	8HA	1/4t - T	-35.00	25.00	CT	1.00	0.61	449.02	318.70	465.69	529.42	60.00	318.67	0.19	FRACTURE	150.01	20.74
103	8HA	1/4t - T	-35.00	25.00	CT	1.00	0.52	344.12	279.00	465.69	529.42	60.00	284.11	0.37	FRACTURE	165.36	32.88
104	8HA	1/4t - T	-35.00	25.00	CT	1.00	0.51	229.41	227.80	465.69	529.42	60.00	234.58	0.14	FRACTURE	167.60	50.67
105	8HA	1/4t - T	-35.00	25.00	CT	1.00	0.52	632.36	378.21	465.69	529.42	60.00	377.01	0.64	FRACTURE	170.20	18.01
106	8HA	1/4t - T	-35.00	-40.00	CT	1.00	0.52	43.14	98.78	498.04	581.38	-5.00	108.98	0.01	FRACTURE	171.97	279.69
107	8HA	1/4t - T	-35.00	-40.00	CT	1.00	0.53	126.47	169.14	498.04	581.38	-5.00	178.48	0.05	FRACTURE	170.34	93.59
108	8HA	1/4t - T	-35.00	-40.00	CT	1.00	0.52	61.77	118.20	498.04	581.38	-5.00	129.09	0.02	FRACTURE	182.47	197.64
109	8HA	1/4t - T	-35.00	-70.00	CT	1.00	0.52	50.00	106.35	522.55	702.95	-35.00	117.18		FRACTURE	186.66	257.76
110	8HA	1/4t - T	-35.00	-90.00	CT	1.00	0.52	41.18	96.51	543.14	726.48	-55.00	106.93		FRACTURE	188.73	324.92
111	8HA	1/4t - T	-35.00	-100.00	CT	1.00	0.55	32.35	85.55	554.91	735.30	-65.00	95.01		FRACTURE	168.59	397.49
112	8HA	1/4t - T	-35.00	25.00	CT	1.00	0.52	60.78	117.26	465.69	529.42	60.00	127.78	0.07	UNLOADED	166.54	188.80
113	8HA	1/4t - T	-35.00	25.00	CT	1.00	0.53	226.47	226.34	465.69	529.42	60.00	232.85	0.07	UNLOADED	163.90	49.08
114	8HA	1/4t - T	-35.00	25.00	CT	1.00	0.52	130.39	171.74	465.69	529.42	60.00	180.67	0.06	UNLOADED	170.83	88.01
115	8HA	1/4t - T	-35.00	-40.00	CT	1.00	0.53	51.96	108.41	498.04	581.38	-5.00	118.92	0.01	UNLOADED	177.20	227.51
116	8HB	1/4t - T	-30.00	-45.00	CT	1.00	0.51	171.57	197.00	549.02	671.57	-15.00	206.34	0.13	FRACTURE	185.17	79.48

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
117	8HB	1/4t - T	-30.00	-45.00	CT	1.00	0.52	81.37	135.67	549.02	671.57	-15.00	147.23	0.02	FRACTURE	186.04	165.17
118	8HB	1/4t - T	-30.00	-70.00	CT	1.00	0.51	87.26	140.49	578.44	700.99	-40.00	152.48	0.01	FRACTURE	191.03	164.04
119	8HB	1/4t - T	-30.00	-90.00	CT	1.00	0.51	43.14	98.78	617.65	725.50	-60.00	109.85		FRACTURE	195.85	359.71
120	8HB	1/4t - T	-30.00	-105.00	CT	1.00	0.51	43.14	98.78	622.55	732.36	-75.00	109.86		FRACTURE	180.59	361.24
121	8HB	1/4t - T	-30.00	-45.00	CT	1.00	0.52	132.35	173.03	465.69	529.42	-15.00	181.78	0.06	UNLOADED	165.57	85.70
122	8HB	1/4t - T	-30.00	-45.00	CT	1.00	0.52	105.88	154.76	465.69	529.42	-15.00	164.37	0.03	UNLOADED	197.77	107.00
123	8HC	1/4t - T	-35.00	-100.00	CT	1.00	0.51	133.33	175.15	622.55	955.89	-65.00	187.01		FRACTURE	212.04	115.60
124	8HC	1/4t - T	-35.00	-100.00	CT	1.00	0.50	48.04	73.16	622.55	955.89	-65.00	81.66		FRACTURE	212.46	665.27
125	8HC	1/4t - T	-35.00	-100.00	CT	1.00	0.49	40.20	95.48	622.55	955.89	-65.00	106.40		FRACTURE	215.44	401.62
126	8HC	1/4t - T	-35.00	-100.00	CT	3.00	0.50	42.16	97.65	622.55	955.89	-65.00	139.56		FRACTURE	207.87	1124.79
127	8HC	1/4t - T	-35.00	-130.00	CT	3.00	0.51	18.63	64.17	666.67	882.36	-95.00	88.53		FRACTURE	198.00	2725.78
128	8HC	1/4t - T	-35.00	-80.00	CT	3.00	0.51	41.18	96.41	573.53	730.40	-45.00	137.54		FRACTURE	190.31	1045.98
129	8HC	1/4t - T	-35.00	-60.00	CT	3.00	0.51	44.12	99.51	553.93	708.34	-25.00	142.12		FRACTURE	186.55	941.80
130	8HC	1/4t - T	-35.00	-40.00	CT	3.00	0.52	67.65	123.69	524.51	686.28	-5.00	177.76		FRACTURE	182.20	573.25
131	8HC	1/4t - T	-35.00	-20.00	CT	3.00	0.50	95.10	146.32	509.81	666.67	15.00	210.45		FRACTURE	182.24	411.89
132	8HC	1/4t - T	-35.00	8.00	CT	3.00	0.51	201.96	213.59	490.20	642.16	43.00	301.68		FRACTURE	184.70	180.91
133	8HC	1/4t - T	-35.00	-75.00	CT	6.00	0.51	30.39	83.08	568.63	725.50	-40.00	136.41		FRACTURE	188.85	2798.73
134	8HC	1/4t - T	-35.00	-50.00	CT	6.00	0.52	75.49	130.82	529.42	691.18	-15.00	222.70		FRACTURE	182.76	1036.65
135	8HC	1/4t - T	-35.00	-20.00	CT	6.00	0.52	142.16	179.49	509.81	666.67	15.00	307.94		FRACTURE	205.27	524.81
136	8HD	1/4t - T	-25.00	-196.00	CT	1.00	0.62	5.42	35.03	936.28	1014.71	-171.00	37.74		FRACTURE	207.30	3361.08
137	8HD	1/4t - T	-25.00	-196.00	CT	1.00	0.62	6.52	38.44	936.28	1014.71	-171.00	41.74		FRACTURE	205.66	2747.37
138	8HD	1/4t - T	-25.00	-196.00	CT	1.00	0.61	5.05	33.79	936.28	1014.71	-171.00	36.28		FRACTURE	198.83	3725.77
139	8HD	1/4t - T	-25.00	-150.00	CT	1.00	0.63	8.27	43.40	669.61	803.93	-125.00	47.47		FRACTURE	178.26	1533.22
140	8HD	1/4t - T	-25.00	-150.00	CT	1.00	0.61	12.26	52.70	669.61	803.93	-125.00	58.24		FRACTURE	181.56	1078.76
141	8HD	1/4t - T	-25.00	-150.00	CT	1.00	0.61	10.29	48.36	669.61	803.93	-125.00	53.23		FRACTURE	177.57	1274.47
142	8HD	1/4t - T	-25.00	-100.00	CT	1.00	0.61	21.08	69.13	580.40	747.06	-75.00	76.72		FRACTURE	171.88	540.59
143	8HD	1/4t - T	-25.00	-100.00	CT	1.00	0.62	16.08	60.14	580.40	747.06	-75.00	66.61		FRACTURE	170.99	706.89
144	8HD	1/4t - T	-25.00	-100.00	CT	1.00	0.61	25.00	75.33	580.40	747.06	-75.00	83.59		FRACTURE	169.12	457.63
145	8HD	1/4t - T	-25.00	-50.00	CT	1.00	0.62	26.96	78.12	521.57	698.04	-25.00	86.35		FRACTURE	162.61	370.57
146	8HD	1/4t - T	-25.00	-50.00	CT	1.00	0.63	58.63	115.01	521.57	698.04	-25.00	124.68		FRACTURE	162.17	170.06
147	8HD	1/4t - T	-25.00	-50.00	CT	1.00	0.62	39.71	99.82	521.57	698.04	-25.00	109.36		FRACTURE	161.64	230.59
148	8HD	1/4t - T	-25.00	-20.00	CT	1.00	0.62	76.08	131.13	500.00	664.71	-20.00	140.31		FRACTURE	159.33	126.75
149	8HD	1/4t - T	-25.00	-20.00	CT	1.00	0.62	52.26	108.81	500.00	664.71	5.00	118.34		FRACTURE	160.17	186.03
150	8HD	1/4t - T	-25.00	-20.00	CT	1.00	0.61	145.10	181.35	500.00	664.71	5.00	188.49		FRACTURE	159.64	67.67
151	8HD	1/4t - T	-25.00	0.00	CT	1.00	0.62	144.12	180.73	486.28	645.10	25.00	187.64		FRACTURE	158.27	65.92
152	8HD	1/4t - T	-25.00	0.00	CT	1.00	0.62	216.67	221.34	486.28	645.10	25.00	227.04		FRACTURE	158.27	43.95
153	8HD	1/4t - T	-25.00	0.00	CT	1.00	0.61	150.98	185.07	486.28	645.10	25.00	191.89		FRACTURE	160.47	63.52
154	8HD	1/4t - T	-25.00	-20.00	CT	4.00	0.52		117.80	500.00	664.71	5.00	181.01		FRACTURE	183.82	804.41
155	8HD	1/4t - T	-25.00	-60.00	CT	4.00	0.52		74.71	529.42	710.79	-35.00	111.07		FRACTURE	189.58	2115.37
156	8HD	1/4t - T	-25.00	-110.00	CT	4.00	0.52		48.67	593.14	759.81	-85.00	67.93		FRACTURE	128.52	5578.70
157																	
158																	
159							••••••										

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1																	
2																	
3	Material	Orient/locat.	RTNDT (°C)	TEMP (°C)	Specimen type	Size	a/W	Jc	KJC	Yield Strength	Tens. Str.	T-RTNDT	KJC(Beff)	delta a (mm)	comments	KJCmax(1T)	b So/J
4	9HA	BASE 1/4t	-35.00	-25.00	SENB	1.00	0.56	1441.19	570.96	539.22	637.26	10.00	570.05		FRACTURE	171.97	8.32
5	9HA	BASE 1/4t	-35.00	-25.00	SENB	1.00	0.58	1352.95	553.21	539.22	637.26	10.00	552.33		FRACTURE	169.19	8.57
6	9HA	BASE 1/4t	-35.00	-25.00	SENB	1.00	0.57	455.89	321.13	539.22	637.26	10.00	321.45		FRACTURE	172.91	25.93
7	9HA	BASE 1/4t	-35.00	-50.00	SENB	1.00	0.56	450.00	319.05	558.83	666.67	-15.00	319.55		FRACTURE	175.52	27.60
8	9HA	BASE 1/4t	-35.00	-50.00	SENB	1.00	0.55	109.80	157.60	558.83	666.67	-15.00	165.17		FRACTURE	179.11	117.79
9	9HA	BASE 1/4t	-35.00	-50.00	SENB	1.00	0.56	1250.99	531.95	558.83	666.67	-15.00	531.13		FRACTURE	179.12	10.02
10	9HA	BASE 1/4t	-35.00	-75.00	SENB	1.00	0.57		76.88	598.04	705.89	-40.00	84.75		FRACTURE	180.22	504.06
11	9HA	BASE 1/4t	-35.00	-75.00	SENB	1.00	0.57		200.88	598.04	705.89	-40.00	206.06		FRACTURE	179.38	73.15
12	9HA	BASE 1/4t	-35.00	-75.00	SENB	1.00	0.57		88.04	598.04	705.89	-40.00	96.55		FRACTURE	181.39	380.81
13	9HA	BASE 1/4t	-35.00	-100.00	SENB	1.00	0.56		156.24	647.06	735.30	-65.00	164.85		FRACTURE	187.27	134.49
14	9HA	BASE 1/4t	-35.00	-100.00	SENB	1.00	0.57		169.88	647.06	735.30	-65.00	177.56		FRACTURE	184.70	110.66
15	9HA	BASE 1/4t	-35.00	-100.00	SENB	1.00	0.57		99.20	647.06	735.30	-65.00	108.44		FRACTURE	191.26	324.53
16	9HA	BASE 1/4t	-35.00	-150.00	SENB	1.00	0.58	17.94	63.71	805.89	835.30	-115.00	70.79		FRACTURE	200.31	970.91
17	9HA	BASE 1/4t	-35.00	-150.00	SENB	1.00	0.57	25.49	75.93	805.89	835.30	-115.00	84.38		FRACTURE	201.25	689.82
18	9HA	BASE 1/4t	-35.00	-150.00	SENB	1.00	0.57	16.96	61.94	805.89	835.30	-115.00	68.83		FRACTURE	189.60	1046.41
19	9HA	BASE 1/4t	-35.00	-25.00	SENB	2.00	0.57	461.77	323.19	539.22	637.26	10.00	385.70		FRACTURE	170.79	51.20
20	9HA	BASE 1/4t	-35.00	-25.00	SENB	2.00	0.58	1049.03	487.13	539.22	637.26	10.00	575.44		FRACTURE	168.19	21.85
21	9HA	BASE 1/4t	-35.00	-25.00	SENB	2.00	0.54	367.65	288.38	539.22	637.26	10.00	347.27		FRACTURE	178.06	68.19
22	9HA	BASE 1/4t	-35.00	-50.00	SENB	2.00	0.54	185.30	204.73	558.83	666.67	-15.00	254.32		FRACTURE	180.68	142.06
23	9HA	BASE 1/4t	-35.00	-50.00	SENB	2.00	0.54	275.49	249.63	558.83	666.67	-15.00	304.56		FRACTURE	179.70	94.52
24	9HA	BASE 1/4t	-35.00	-50.00	SENB	2.00	0.54	226.47	226.34	558.83	666.67	-15.00	278.67		FRACTURE	183.55	116.23
25	9HA	BASE 1/4t	-35.00	-75.00	SENB	2.00	0.54	36.18	90.46	598.04	705.89	-40.00	116.79		FRACTURE	185.97	775.33
26	9HA	BASE 1/4t	-35.00	-75.00	SENB	2.00	0.55	149.02	183.60	598.04	705.89	-40.00	230.74		FRACTURE	184.14	184.54
27	9HA	BASE 1/4t	-35.00	-75.00	SENB	2.00	0.54	68.63	124.59	598.04	705.89	-40.00	160.36		FRACTURE	187.85	407.82
28	9HA	BASE 1/4t	-35.00	-100.00	SENB	2.00	0.55	22.45	71.26	647.06	735.30	-65.00	91.35		FRACTURE	190.02	1331.16
29	9HA	BASE 1/4t	-35.00	-100.00	SENB	2.00	0.55	20.88	68.73	647.06	735.30	-65.00	87.93		FRACTURE	190.43	1437.47
30	9HA	BASE 1/4t	-35.00	-100.00	SENB	2.00	0.54	45.59	101.55	647.06	735.30	-65.00	131.47		FRACTURE	197.85	662.80
31	9HA	BASE 1/4t	-35.00	-150.00	SENB	2.00	0.55	19.41	66.26	805.89	835.30	-115.00	84.81		FRACTURE	207.50	1925.94
32	9HA	BASE 1/4t	-35.00	-150.00	SENB	2.00	0.55	14.51	57.29	805.89	835.30	-115.00	72.44		FRACTURE	206.58	2553.94
33	9HA	BASE 1/4t	-35.00	-150.00	SENB	2.00	0.55	12.06	52.23	805.89	835.30	-115.00	65.42		FRACTURE	194.36	3093.47
34	9HA	HAZ 1/4t	-70.00	-25.00	SENB	1.00	0.52	1463.74	575.41	539.22	637.26	45.00	574.50		FRACTURE	179.69	8.94
35	9HA	HAZ 1/4t	-70.00	-25.00	SENB	1.00	0.53	1405.89	563.93	539.22	637.26	45.00	563.04		FRACTURE	179.31	9.27
36	9HA	HAZ 1/4t	-70.00	-25.00	SENB	1.00	0.53	1610.80	603.63	539.22	637.26	45.00	602.66		FRACTURE	181.54	8.09
37	9HA	HAZ 1/4t	-70.00	-50.00	SENB	1.00	0.52	1308.83	544.11	558.83	666.67	20.00	543.27		FRACTURE	183.40	10.36
38	9HA	HAZ 1/4t	-70.00	-50.00	SENB	1.00	0.53	1084.32	495.25	558.83	666.67	20.00	494.53		FRACTURE	182.62	12.40
39	9HA	HAZ 1/4t	-70.00	-50.00	SENB	1.00	0.54	1494.13	581.36	558.83	666.67	20.00	580.43		FRACTURE	183.15	8.77
40	9HA	HAZ 1/4t	-70.00	-75.00	SENB	1.00	0.53	394.12	298.58	598.04	705.89	-5.00	300.09		FRACTURE	187.18	36.05
41	9HA	HAZ 1/4t	-70.00	-75.00	SENB	1.00	0.54	1156.87	511.55	598.04	705.89	-5.00	510.80		FRACTURE	186.37	12.18
42	9HA	HAZ 1/4t	-70.00	-75.00	SENB	1.00	0.52	1190.21	518.87	598.04	705.89	-5.00	518.11		FRACTURE	192.90	12.40
43	9HA	HAZ 1/4t	-70.00	-100.00	SENB	1.00	0.52	154.90	187.19	647.06	735.30	-30.00	194.97		FRACTURE	195.60	102.22
44	9HA	HAZ 1/4t	-70.00	-100.00	SENB	1.00	0.51	524.51	344.45	647.06	735.30	-30.00	345.37		FRACTURE	196.82	30.56
45	9HA	HAZ 1/4t	-70.00	-100.00	SENB	1.00	0.51	250.98	238.27	647.06	735.30	-30.00	243.35		FRACTURE	205.48	64.93
46	9HA	HAZ 1/4t	-70.00	-150.00	SENB	1.00	0.52	26.47	77.38	805.89	835.30	-80.00	86.22		FRACTURE	214.01	751.19
47	9HA	HAZ 1/4t	-70.00	-150.00	SENB	1.00	0.50	19.02	65.59	805.89	835.30	-80.00	73.12		FRACTURE	203.97	1080.03
48	9HA	HAZ 1/4t	-70.00	-25.00	SENB	2.00	0.52			539.22	637.26	45.00			FRACTURE	180.63	ERR:9
49	9HA	HAZ 1/4t	-70.00	-25.00	SENB	2.00	0.51	1752.96	629.70	539.22	637.26	45.00	744.14		FRACTURE	184.77	15.40
50	9HA	HAZ 1/4t	-70.00	-50.00	SENB	2.00	0.53	1539.23	590.06	558.83	666.67	20.00	697.26		FRACTURE	183.20	17.58
51	9HA	HAZ 1/4t	-70.00	-50.00	SENB	2.00	0.52	1636.29	608.38	558.83	666.67	20.00	718.95		FRACTURE	187.87	16.85
52	9HA	HAZ 1/4t	-70.00	-75.00	SENB	2.00	0.50	65.00	121.26	598.04	705.89	-5.00	156.64		FRACTURE	193.11	465.29
53	9HA	HAZ 1/4t	-70.00	-75.00	SENB	2.00	0.51	740.20	409.19	598.04	705.89	-5.00	486.34		FRACTURE	193.49	40.12
54	9HA	HAZ 1/4t	-70.00	-100.00	SENB	2.00	0.51	106.86	155.48	647.06	735.30	-30.00	199.26		FRACTURE	197.42	301.89
55	9HA	HAZ 1/4t	-70.00	-100.00	SENB	2.00	0.51	59.80	116.31	647.06	735.30	-30.00	150.74		FRACTURE	205.06	542.75
56	9HA	HAZ 1/4t	-70.00	-150.00	SENB	2.00	0.50	67.55	123.61	805.89	835.30	-80.00	161.19		FRACTURE	216.65	603.33
57	9HA	HAZ 1/4t	-70.00	-150.00	SENB	2.00	0.50	48.73	104.99	805.89	835.30	-80.00	137.01		FRACTURE	201.68	841.47
58	9HA	WELD 1/4t	-75.00	-25.00	SENB	1.00	0.53	1264.72	534.87	529.42	607.85	50.00	534.03		FRACTURE	175.93	10.07

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
59	9HA	WELD 1/4t	-75.00	-25.00	SENB	1.00	0.52	1057.85	489.17	529.42	607.85	50.00	488.45		FRACTURE	176.67	12.14
60	9HA	WELD 1/4t	-75.00	-25.00	SENB	1.00	0.52	1048.05	486.90	529.42	607.85	50.00	486.19		FRACTURE	179.31	12.41
61	9HA	WELD 1/4t	-75.00	-50.00	SENB	1.00	0.51	570.59	359.26	539.22	627.46	25.00	359.38		FRACTURE	181.55	23.61
62	9HA	WELD 1/4t	-75.00	-50.00	SENB	1.00	0.52	437.26	314.50	539.22	627.46	25.00	315.30		FRACTURE	180.06	30.30
63	9HA	WELD 1/4t	-75.00	-50.00	SENB	1.00	0.52	598.04	367.80	539.22	627.46	25.00	367.77		FRACTURE	180.89	21.97
64	9HA	WELD 1/4t	-75.00	-75.00	SENB	1.00	0.52	161.77	191.29	558.83	648.04	0.00	197.48		FRACTURE	183.14	84.89
65	9HA	WELD 1/4t	-75.00	-75.00	SENB	1.00	0.51	90.20	142.84	558.83	648.04	0.00	151.75		FRACTURE	185.41	156.03
66	9HA	WELD 1/4t	-75.00	-75.00	SENB	1.00	0.52	201.96	213.74	558.83	648.04	0.00	218.53		FRACTURE	184.86	67.14
67	9HA	WELD 1/4t	-75.00	-100.00	SENB	1.00	0.52	113.73	160.39	588.24	686.28	-25.00	168.70		FRACTURE	187.42	126.04
68	9HA	WELD 1/4t	-75.00	-100.00	SENB	1.00	0.52	33.92	87.60	588.24	686.28	-25.00	96.43		FRACTURE	188.20	426.10
69	9HA	WELD 1/4t	-75.00	-100.00	SENB	1.00	0.52	78.73	133.45	588.24	686.28	-25.00	142.85		FRACTURE	199.31	183.60
70	9HA	WELD 1/4t	-75.00	-150.00	SENB	1.00	0.52	25.49	75.93	687.26	841.18	-75.00	84.29		FRACTURE	206.10	662.50
71	9HA	WELD 1/4t	-75.00	-150.00	SENB	1.00	0.51	26.76	77.81	687.26	841.18	-75.00	86.36		FRACTURE	190.50	636.19
72	9HA	WELD 1/4t	-75.00	-25.00	SENB	2.00	0.50	1873.54	651.00	529.42	607.85	50.00	769.36		FRACTURE	180.53	14.32
73	9HA	WELD 1/4t	-75.00	-25.00	SENB	2.00	0.52	2166.68	700.08	529.42	607.85	50.00	827.51		FRACTURE	179.86	12.08
74	9HA	WELD 1/4t	-75.00	-50.00	SENB	2.00	0.51	794.12	423.83	539.22	627.46	25.00	502.33		FRACTURE	181.55	33.92
75	9HA	WELD 1/4t	-75.00	-50.00	SENB	2.00	0.51	605.89	370.21	539.22	627.46	25.00	440.61		FRACTURE	182.59	44.19
76	9HA	WELD 1/4t	-75.00	-75.00	SENB	2.00	0.52	73.53	128.97	558.83	648.04	0.00	165.65		FRACTURE	182.95	372.72
77	9HA	WELD 1/4t	-75.00	-75.00	SENB	2.00	0.52	115.69	161.77	558.83	648.04	0.00	205.17		FRACTURE	185.44	235.91
78	9HA	WELD 1/4t	-75.00	-100.00	SENB	2.00	0.52	41.67	97.08	588.24	686.28	-25.00	125.53		FRACTURE	188.40	695.24
79	9HA	WELD 1/4t	-75.00	-100.00	SENB	2.00	0.52	54.90	111.44	588.24	686.28	-25.00	144.01		FRACTURE	199.73	528.73
80	9HA	WELD 1/4t	-75.00	-150.00	SENB	2.00	0.52	40.20	95.35	687.26	841.18	-75.00	123.77		FRACTURE	206.74	845.47
81	9HA	WELD 1/4t	-75.00	-150.00	SENB	2.00	0.51	26.18	76.95	687.26	841.18	-75.00	99.25		FRACTURE	189.61	1311.68
82	9HD	BASE 1/4t	-30.00	12.00	SENB	1.00	0.50	555.89	354.60	432.36	585.30	42.00	354.40	0.80	FRACTURE	170.60	19.67
83	9HD	BASE 1/4t	-30.00	12.00	SENB	1.00	0.51	954.91	464.76	432.36	585.30	42.00	464.06	1.90	FRACTURE	168.87	11.22
84	9HD	BASE 1/4t	-30.00	12.00	SENB	1.00	0.52	410.79	304.83	432.36	585.30	42.00	305.13	0.60	FRACTURE	168.17	25.86
85	9HD	BASE 1/4t	-30.00	12.00	SENB	1.00	0.52	875.50	445.02	432.36	585.30	42.00	444.36	1.60	FRACTURE	173.08	12.08
86	9HD	BASE 1/4t	-30.00	-52.00	SENB	1.00	0.51	41.18	96.51	478.44	650.01	-22.00	104.96		FRACTURE	180.48	290.24
87	9HD	BASE 1/4t	-30.00	-74.00	SENB	1.00	0.51	25.49	75.93	503.93	674.52	-44.00	83.64		FRACTURE	179.12	497.86
88	9HD	BASE 1/4t	-30.00	-26.00	SENB	1.00	0.52	94.12	145.91	455.89	622.55	4.00	152.95		FRACTURE	172.29	119.51
89	9HD	BASE 1/4t	-30.00	-11.00	SENB	1.00	0.51	170.59	196.44	444.12	607.85	19.00	200.49		FRACTURE	180.20	64.50
90	9HD	BASE 1/4t	-30.00	-107.00	SENB	1.00	0.50	12.75	53.69	552.95	714.71	-77.00	59.27		FRACTURE	180.42	1097.01
91	9HD	BASE 1/4t	-30.00	12.00	SENB	1.00	0.52	707.85	400.15	432.36	585.30	42.00	399.65	1.40	UNLOADED	168.17	15.01
92	9HD	BASE 1/4t	-30.00	12.00	SENB	1.00	0.52	258.83	241.96	432.36	585.30	42.00	243.76	0.15	UNLOADED	177.40	41.05
93	9HD	HAZ 1/4t	-65.00	-50.00	SENB	1.00	0.53	1269.62	535.90	598.04	700.01	15.00	535.09	1.90	FRACTURE	188.79	11.19
94	9HD	HAZ 1/4t	-65.00	-73.00	SENB	1.00	0.52	146.08	181.78	625.50	728.44	-8.00	189.54		FRACTURE	196.36	104.78
95	9HD	HAZ 1/4t	-65.00	-103.00	SENB	1.00	0.54	42.16	97.65	674.52	767.65	-38.00	107.34		FRACTURE	199.54	378.47
96	9HD	HAZ 1/4t	-65.00	-143.00	SENB	1.00	0.52	9.80	47.09	756.87	813.73	-78.00	51.91		FRACTURE	207.12	1889.09
97	9HD	HAZ 1/4t	-65.00	-125.00	SENB	1.00	0.52	33.33	86.83	718.63	793.14	-60.00	96.21		FRACTURE	198.21	527.55
98	9HD	WELD 1/4t	-60.00	-50.00	SENB	1.00	0.51	112.75	159.70	598.04	700.99	10.00	168.33		FRACTURE	192.94	131.42
99	9HD	WELD 1/4t	-60.00	-75.00	SENB	1.00	0.51	53.92	110.44	627.46	730.40	-15.00	120.44		FRACTURE	198.18	290.67
100	9HD	WELD 1/4t	-60.00	-99.00	SENB	1.00	0.52	21.57	69.85	666.67	762.75	-39.00	77.54		FRACTURE	192.94	756.35
101	9HD	WELD 1/4t	-60.00	-32.00	SENB	1.00	0.51	328.43	272.57	579.42	678.44	28.00	275.06		FRACTURE	197.69	44.07
102	9HD	WELD 1/4t	-60.00	-135.00	SENB	1.00	0.50	3.92	29.78	740.20	803.93	-75.00	31.64		FRACTURE	200.69	4811.17
103	9HD	WELD 1/4t	-60.00	-15.00	SENB	1.00	0.52	722.55	404.28	565.69	656.87	45.00	404.01		FRACTURE	183.59	19.24
104	9HD	O-HAZ 1/4t	-55.00	-49.00	SENB	1.00	0.53	492.16	333.66	475.49	647.06	6.00	333.73		FRACTURE	172.65	23.15
105	9HD	O-HAZ 1/4t	-55.00	-29.00	SENB	1.00	0.54	522.55	343.81	457.85	624.51	26.00	343.68	1.00	FRACTURE	174.05	20.73
106	9HD	O-HAZ 1/4t	-55.00	-74.00	SENB	1.00	0.53	186.28	205.27	503.93	674.52	-19.00	209.60	1.10	FRACTURE	181.23	65.09
107	9HD	O-HAZ 1/4t	-55.00	-97.00	SENB	1.00	0.52	18.63	64.91	537.26	702.95	-42.00	71.72		FRACTURE	187.28	702.83
108	9HD	O-HAZ 1/4t	-55.00	-125.00	SENB	1.00	0.52	20.59	68.24	583.34	735.30	-70.00	75.53		FRACTURE	181.34	690.43
109	9HD	O-HAZ 1/4t	-55.00	-13.00	SENB	1.00	0.50	721.57	404.01	446.08	609.81	42.00	403.54	2.50	FRACTURE	179.34	15.76
110	9HA	BASE 1/4t	-35.00	-40.00	CT	1.00	0.49	189.22	206.88	548.04	669.61	-5.00	216.23	0.16	FRACTURE	192.32	75.60
111	9HA	BASE 1/4t	-35.00	-70.00	CT	1.00	0.51	88.24	141.28	591.18	704.91	-35.00	153.53	0.04	FRACTURE	187.42	168.05
112	9HC	BASE 1/4t	-25.00	-50.00	CT	1.00	0.52	42.16	97.65	480.40	647.06	-25.00	107.69		FRACTURE	173.55	278.84
113	9HC	BASE 1/4t	-25.00	-50.00	CT	1.00	0.52	31.37	84.24	450.98	607.85	-25.00	93.18		FRACTURE	170.47	348.83
114	9HC	BASE 1/4t	-25.00	-25.00	CT	1.00	0.52	160.79	190.71	450.98	607.85	0.00	198.45	0.10	FRACTURE	170.30	69.21
115	9HC	BASE 1/4t	-25.00	0.00	CT	1.00	0.52	178.43	200.90	441.18	588.24	25.00	207.93	0.10	FRACTURE	168.09	60.00
116	9HC	BASE 1/4t	-25.00	0.00	CT	1.00	0.52	228.43	227.31	441.18	588.24	25.00	233.62	0.11	FRACTURE	168.79	47.26

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117	9HC	BASE 1/4t	-25.00	0.00	CT	1.00	0.52	125.49	168.48	441.18	588.24	25.00	176.97	0.05	UNLOADED	168.44	85.67
118	9HC	BASE 1/4t	-25.00	0.00	CT	1.00	0.52	400.00	300.80	441.18	588.24	25.00	304.15	0.44	UNLOADED	175.54	27.10
119	9HC	HAZ 1/4t	-55.00	-50.00	CT	1.00	0.55	295.10	258.36	552.95	667.65	5.00	265.00	0.27	UNLOADED	178.36	43.18
120	9HC	HAZ 1/4t	-55.00	-50.00	CT	1.00	0.53	519.61	342.84	552.95	667.65	5.00	345.76	0.51	UNLOADED	181.87	25.50
121	9HC	HAZ 1/4t	-55.00	-50.00	CT	1.00	0.54	287.26	254.91	552.95	667.65	5.00	261.80	0.32	FRACTURE	180.71	45.53
122	9HC	HAZ 1/4t	-55.00	-50.00	CT	1.00	0.51	84.31	138.10	552.95	667.65	5.00	149.78	0.06	FRACTURE	184.94	162.48
123	9HC	HAZ 1/4t	-55.00	-50.00	CT	1.00	0.54	115.69	161.77	552.95	667.65	5.00	172.40	0.09	FRACTURE	182.22	113.06
124	9HC	HAZ 1/4t	-55.00	-75.00	CT	1.00	0.53	125.49	168.48	587.26	688.24	-20.00	179.58		FRACTURE	188.45	112.60
125	9HC	HAZ 1/4t	-55.00	-100.00	CT	1.00	0.53	33.33	86.83	637.26	717.65	-45.00	96.81		FRACTURE	186.77	458.06
126	9HC	HAZ 1/4t	-55.00	-25.00	CT	2.00	0.52	547.06	351.78	530.40	650.01	30.00	426.68	0.70	FRACTURE	182.66	47.75
127	9HC	HAZ 1/4t	-55.00	-50.00	CT	2.00	0.56	66.67	122.80	552.95	667.65	5.00	159.54		FRACTURE	176.64	368.71
128	9HC	HAZ 1/4t	-55.00	-75.00	CT	2.00	0.53	25.49	75.93	587.26	688.24	-20.00	97.81		FRACTURE	188.65	1111.06
129	9HC	HAZ 1/4t	-55.00	-100.00	CT	2.00	0.52	31.37	84.24	637.26	717.65	-45.00	109.22		FRACTURE	132.39	987.88
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13. ABSTRACT *(Maximum 200 words)*

Cleavage fracture toughness can be influenced by specimen dimensions. Crack tip constraint can relax in small specimens, resulting in higher apparent toughness. Moreover, there is a statistical sampling effect, where thicker specimens tend to have lower toughness than thin specimens due to an increased sample volume.
In deeply notched bend and compact specimens, theoretical modeling, finite element analysis, and experimental data indicate that the results will not be significantly influenced by crack tip constraint as long as the following specimen size requirements are met:

$$a/W > 0.5, B \geq (MJc)/\sigma_Y, B/b \geq 1$$

where a is the crack length, W is the specimen width, B is the specimen thickness, b is the uncracked ligament, J_c is the critical J value, σ_y is the effective yield strength and M is a dimensionless constant. These size requirements are conservative if M is set equal to 100; M– 50 appears to be adequate for many materials, but the authors recommend the stricter requirement until further validation is performed. When specimens meet the above requirements, fracture toughness should not be influenced by size, provided statistical thickness effects are taken into account.

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